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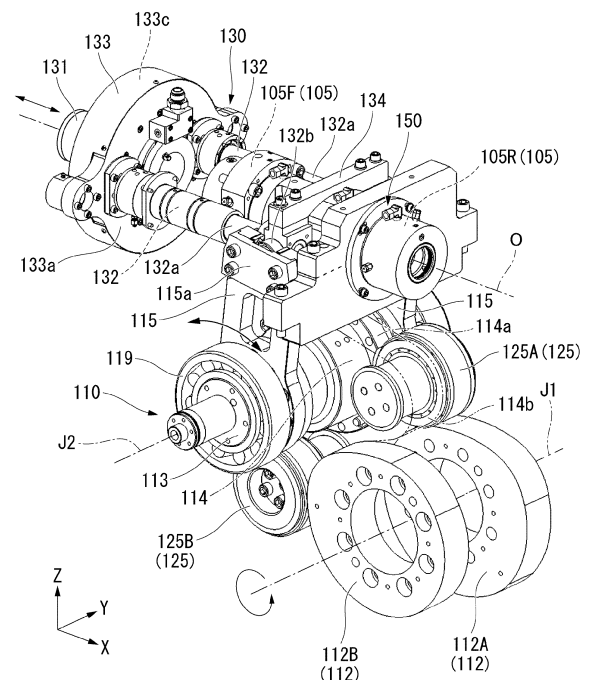
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(54) **CAN BODY MAKER AND FRAME FOR DRIVE MECHANISM**

(57) A can body maker includes a ram shaft extending in a front-rear direction, a punch disposed at a front end portion of the ram shaft, a reciprocating linear motion mechanism connected to a rear end portion of the ram shaft to reciprocate and linearly move the ram shaft in the front-rear direction, a die having a through hole into which the punch is inserted, a cup holding mechanism which presses a cup-shaped body against an end face in which the through hole of the die opens, and a cup holder drive mechanism that oscillates the cup holding mechanism in the front-rear direction, wherein the cup holder drive mechanism has a cam structure and is disposed directly below the cup holding mechanism.

FIG. 3



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a can body maker.

[0002] Further, the present invention relates to a frame for a drive mechanism to which a drive mechanism for reciprocating a ram shaft and a cup holder is attached when a cup-shaped body is subjected to DI processing at the time of manufacturing a DI can, and a can body maker provided with the frame for a drive mechanism.

Description of Related Art

[0003] In the related art, a drawing and ironing (DI) can in a bottomed tubular shape is known. ADI can is manufactured by a blank in a disc shape made of an alloy such as aluminum or iron being subjected to cupping processing, DI processing, or the like. In cupping processing, a blank is subjected to drawing processing to form a cup-shaped body. In DI processing, the cup-shaped body is held by a cup holder and is subjected to drawing and ironing processing between a punch and a die.

[0004] As a can body maker that performs DI processing on a cup-shaped body, for example, those described in Patent Documents 1 and 2 are known. The can body maker includes a ram shaft extending in a front-rear direction, a punch disposed at a front end portion of the ram shaft, a reciprocating linear motion mechanism connected to a rear end portion of the ram shaft to reciprocate and linearly move the ram shaft in the front-rear direction, a die having a through hole into which the punch is inserted, a cup holding mechanism (a cup holder) having a cup holder sleeve which presses a cup-shaped body against an end face in which the through hole of the die opens, and a cup holder drive mechanism that oscillates the cup holding mechanism in the front-rear direction.

[0005] In Patent Document 1, a blank holder drive device is connected to a cup holding mechanism via a coupling device.

[0006] In Patent Document 2, a cup holding mechanism is oscillated in the front-rear direction by a servomotor.

[0007] Further, as a can body which is filled with contents such as beverages and sealed, a two-piece can that includes a DI can in a bottomed tubular shape having a can wall (a wall) and a can bottom (a bottom) and a can lid in a disc shape that is wound around and fastened to an opening end portion of the DI can is known. Further, a bottle can in which a cap is screwed to an opening end portion of a DI can that is subjected to die necking processing referred to as bottle necking and the like after DI processing is also well known.

[0008] ADI can used for such a can body is formed in

a bottomed tubular shape by a blank in a disc shape obtained by punching a plate material formed of an aluminum alloy material being subjected to a cupping process (a drawing process) and a DI process (a drawing and ironing process).

[0009] In a cupping process, a blank is subjected to cupping processing (drawing processing) to form a cup-shaped body which is an intermediate formed body in the process of transitioning from a blank to a DI can. Further, in a DI process, a punch sleeve is fitted inside the cup-shaped body, a plurality of dies are fitted to the outside thereof, and the cup-shaped body is subjected to drawing and ironing processing between them. That is, the cup-shaped body is subjected to drawing and ironing (DI) processing to obtain a DI can.

[0010] In performing DI processing on the cup-shaped body, for example, a can body maker as described in Patent Document 3 is used. This can body maker has a reciprocating linear motion mechanism for linearly reciprocating a ram shaft that supports a punch sleeve.

[0011] In the related art, such a reciprocating linear motion mechanism is supported by a division-type frame for a drive mechanism which sandwiches the reciprocating linear motion mechanism between a lower frame division body that supports a lower half of a housing of the reciprocating linear motion mechanism and an upper frame division body that is provided along an upper half of the housing of the reciprocating linear motion mechanism.

[Patent Documents]

[0012]

[Patent Document 1] United States Patent Application, Publication No. 2018/0272410

[Patent Document 2] Japanese Patent No. 6456959

[Patent Document 3] Japanese Unexamined Patent Application, First Publication No. 2018-054065

SUMMARY OF THE INVENTION

[0013] In the can body maker of the related art, it is required to improve the forming accuracy of a can, to suppress the occurrence of a defective can, and to improve the production efficiency of a can. Further, in the can body maker of the related art, the cup holder drive mechanism may have a cam structure. In this case, the cup holder drive mechanism is disposed apart from the cup holding mechanism in a left-right direction orthogonal to a front-rear direction. Specifically, this cup holder drive mechanism is connected to the cup holding mechanism via a plurality of shafts continuously provided in the left-right direction, joint members connecting these shafts, a pair of arms that move the cup holding mechanism back and forth, and the like. For this reason, connection portions between the shafts and the joint members may be loosened, or the long shaft may be twisted. That is, there

is a possibility that loss in a force transmitted from the cup holder drive mechanism to the cup holding mechanism may occur, or a load acting on the pair of arms may become uneven, which may affect component life.

[0014] A first object of the present invention is to provide a can body maker capable of improving the forming accuracy of a can, suppressing the occurrence of a defective can, and improving the production efficiency of a can, and a frame for a drive mechanism of the can body maker.

[0015] A second object of the present invention is to provide a can body maker capable of suppressing the loss in a force transmitted from the cup holder drive mechanism to the cup holding mechanism to be small and extending component life.

[0016] Further, since the division type frame for a drive mechanism of the related art is configured to fix the reciprocating linear motion mechanism by two frame division bodies being fastened such that the reciprocating linear motion mechanism is sandwiched therebetween, there is a problem that the attachment accuracy of the reciprocating linear motion mechanism is likely to deteriorate and the shake or the like of the ram shaft is likely to increase. When the shake of the ram shaft increases, it is difficult to secure the forming accuracy of a can.

[0017] Further, at the time of maintenance of the reciprocating linear motion mechanism, it is necessary to go through inconvenient processes such as removing the upper frame division body to expose the reciprocating linear motion mechanism and then suspending and taking out the reciprocating linear motion mechanism, and thus there is a problem that the maintainability also deteriorates.

[0018] The present invention is made in consideration of such circumstances. A third object of the present invention is to provide a frame for a drive mechanism capable of improving the attachment accuracy of the reciprocating linear motion mechanism and facilitating maintenance of the reciprocating linear motion mechanism, and a can body maker including the frame for a drive mechanism.

[0019] A can body maker according an aspect of the present invention includes a ram shaft extending in a front-rear direction, a punch disposed at a front end portion of the ram shaft, a reciprocating linear motion mechanism connected to a rear end portion of the ram shaft to reciprocate and linearly move the ram shaft in the front-rear direction, a die having a through hole into which the punch is inserted, a cup holding mechanism pressing a cup-shaped body against an end face in which the through hole of the die opens (which has a cup holder sleeve, for example), and a cup holder drive mechanism that oscillates the cup holding mechanism in the front-rear direction, wherein the cup holder drive mechanism has a cam structure and is disposed directly below the cup holding mechanism.

[0020] In the can body maker of the present invention, since the cup holder drive mechanism has a cam struc-

ture, it is easy to synchronize the reciprocating linear motion mechanism that moves the ram shaft back and forth with the cup holder drive mechanism. Since the cup holder drive mechanism is disposed directly below the cup holding mechanism (the cup holder), a distance between these mechanisms can be suppressed to be short. To connect the cup holder drive mechanism and the cup holding mechanism, it is not necessary to continuously provide a plurality of shafts between the mechanisms or to use a joint member or the like as in the related art. According to the present invention, the number of the components can be reduced and the manufacturing cost can be reduced. Further, the size of the member connecting the cup holder drive mechanism and the cup holding mechanism can be suppressed to be small.

[0021] According to the present invention, it is possible to suppress the occurrence of loss in the force transmitted from the cup holder drive mechanism to the cup holding mechanism. The power for driving the cup holder drive mechanism can be reduced, resulting in a reduction in energy. Further, it is easy to equalize a load acting on each member that connects the cup holder drive mechanism and the cup holding mechanism, and it is possible to suppress the occurrence of variation in component life of each member, and as a result, to extend the component life. Since the cup holding mechanism which is moved back and forth by the cup holder drive mechanism stably presses the cup-shaped body against the end face of the die, the forming accuracy of the can is well maintained. The structure of the can body maker is simplified, and an outer shape thereof can be kept to be compact.

[0022] According to the present invention, it is possible to improve the forming accuracy of the can, to suppress the occurrence of a defective can, and to improve the production efficiency of the can.

[0023] Other aspect of the present invention is a cup holder with a driving mechanism including: a cup holding mechanism pressing a cup-shaped body against an end face in which a through hole of a die opens; and a cup holder drive mechanism that oscillates the cup holding mechanism in the front-rear direction, wherein the cup holder drive mechanism has a cam structure and is disposed directly below the cup holding mechanism.

[0024] Preferably, the above-described can body maker further includes a gear transmitting a rotational driving force around a rotation axis of the reciprocating linear motion mechanism to the cup holder drive mechanism.

[0025] In this case, loss in the power transmission is suppressed to be smaller than that in the configuration in which the rotational driving force of the reciprocating linear motion mechanism is transmitted to the cup holder drive mechanism via, for example, a belt or the like. In addition, the can body maker can be configured more compactly.

[0026] In the above-described can body maker, preferably, the cup holder drive mechanism has a cam which is rotated (for example, around a first central axis extending in a left-right direction orthogonal to the front-rear

direction), an oscillation unit oscillated (for example, around a second central axis parallel to the first central axis) by being in contact with the cam, and a pair of arms disposed on both sides of the ram shaft (for example, in the left-right direction) and oscillate (for example, around the second central axis) together with the oscillation unit to move the cup holding mechanism back and forth.

[0027] In this case, the rotation (for example, around the first central axis) which is input to the cup holder drive mechanism is converted into the oscillation (for example, around the second central axis) by the cam and the oscillation unit, and the oscillation is output from the pair of arms. The pair of arms are disposed on both sides of the ram shaft (for example, in the left-right direction) and act evenly on the cup holding mechanism. As a result, the cup holding mechanism stably presses the cup-shaped body against the end face of the die, and the forming accuracy of the can is stably ensured.

[0028] In the above-described can body maker, preferably, the cup holding mechanism has a cup holder sleeve and a biasing unit (for example, which is provided between the cup holder sleeve and a pair of rods connected to the pair of arms) which allows the cup holder sleeve to be biased forward with air pressure.

[0029] In this case, the cup holding mechanism biases the cup holder sleeve forward by the biasing unit with the air pressure, and thus pressure (cup holding pressure) with which the cup holder sleeve presses the cup-shaped body against the end face of the die is stabilized from the initial stage of the operation of the machine. Further, according to above-described configuration of the present invention, the cup holding pressure is easily adjusted as compared with the case in which the cup holder sleeve is biased forward with, for example, hydraulic pressure.

[0030] Preferably, the above-described can body maker further includes a bearing supporting the ram shaft to be slidable in the front-rear direction, wherein the cup holder drive mechanism is disposed directly below the bearing.

[0031] In this case, since the cup holding mechanism, the bearing, and the cup holder drive mechanism are disposed adjacent to each other in the up-down direction, the can body maker can be configured more compactly.

[0032] Preferably, the above-described can body maker further includes bearings supporting the ram shaft to be slidable in the front-rear direction, wherein a pair of the bearings are provided at an interval in the front-rear direction, and wherein the pair of bearings are integrally formed.

[0033] In this case, the pair of bearings, that is, a front bearing and a rear bearing, can be easily aligned, and the centering work at the time of assembly or the like can be omitted or simplified. Since the straightness of the ram shaft is maintained well, the forming accuracy of the can is stably ensured.

[0034] A frame for a drive mechanism according to an aspect of the present invention is provided in a can body maker having a ram shaft which has a punch provided

at a front end portion thereof, a die in which a through hole into which the punch is inserted is formed and a cup-shaped body extruded by the punch is passed through the through hole to perform drawing processing and ironing processing on the cup-shaped body, a cup holder which presses the cup-shaped body against an end face of the die, and a drive mechanism reciprocating the ram shaft, to house the drive mechanism, wherein the drive mechanism has a reciprocating linear motion mechanism reciprocating the ram shaft, wherein the reciprocating linear motion mechanism has a housing in a cylindrical shape (for example, the reciprocating linear motion mechanism is housed in a housing in a cylindrical shape), and wherein the frame for a drive mechanism is formed by side plates (for example, one side plate and another side plate), a bottom plate, a front plate, and a back plate being integrally fixed to each other, and a circular opening surrounding a circumferential surface of the housing to house the reciprocating linear motion mechanism is integrally formed in the back plate.

[0035] According to the frame for a drive mechanism of the present invention, the frame for a drive mechanism for attaching the reciprocating linear motion mechanism thereto is integrally formed, and the reciprocating linear motion mechanism is housed in a circular opening capable of housing the reciprocating linear motion mechanism and is fixed thereto. In the present invention, the attachment accuracy of the reciprocating linear motion mechanism can be improved as compared with the frame for a drive mechanism of the related art which is constituted by the division bodies obtained by dividing one into a plurality. As a result, it is possible to suppress vibration during the operation of the reciprocating linear motion mechanism and the shake of the reciprocating motion of the ram shaft, and thus it is possible to perform the drawing and ironing processing on the cup-shaped body with high accuracy. Further, it is possible to remove the reciprocating linear motion mechanism from the circular opening without dividing the frame for a drive mechanism, and thus the maintainability is excellent.

[0036] According to the present invention, it is possible to improve the forming accuracy of the can, to suppress the occurrence of a defective can, and to improve the production efficiency of the can.

[0037] Further, in the present invention, the drive mechanism may have a cup holder drive mechanism reciprocating the cup holder, and the cup holder drive mechanism may be supported between the front plate and the back plate.

[0038] Further, in the present invention, a gear transmitting a rotational force of the reciprocating linear motion mechanism to the cup holder drive mechanism may be rotatably formed in the reciprocating linear motion mechanism.

[0039] Further, in the present invention, the back plate may extend upward more than the front plate.

[0040] Further, in the present invention, a part of the front plate may be attachably and detachably formed.

[0041] Further, in the present invention, an extension portion in which the die is disposed may be integrally fixed to an outside of the side plate (for example, the one side plate).

[0042] A can body maker according an aspect of the present invention which includes the frame for a drive mechanism described above includes at least the frame for a drive mechanism, and the reciprocating linear motion mechanism.

[0043] According to the can body maker of one aspect of the present invention, it is possible to improve the forming accuracy of a can, to suppress the occurrence of a defective can, and to improve the production efficiency of a can.

[0044] According to the can body maker of one aspect of the present invention, it is possible to suppress loss in a force transmitted from the cup holder drive mechanism to the cup holding mechanism to be small and to extend component life.

[0045] According to one aspect of the present invention, it is possible to provide a frame for a drive mechanism capable of improving the attachment accuracy of the reciprocating linear motion mechanism and facilitating maintenance of the reciprocating linear motion mechanism, and a can body maker including the frame for a drive mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046]

Fig. 1 is a schematic view schematically showing a can body maker according to a first embodiment.

Fig. 2 is a perspective view showing a part of a configuration of the can body maker.

Fig. 3 is a partial perspective view showing a cup holder drive mechanism, a cup holding mechanism, and a bearing unit of the can body maker.

Fig. 4A is a side view illustrating an operation of the cup holder drive mechanism and the cup holding mechanism of the can body maker.

Fig. 4B is a side view illustrating an operation of the cup holder drive mechanism and the cup holding mechanism of the can body maker.

Fig. 4C is a side view illustrating an operation of the cup holder drive mechanism and the cup holding mechanism of the can body maker.

Fig. 5 is a schematic configuration view showing an example of a can body maker according to a second embodiment.

Fig. 6 is a perspective view showing an example of a reciprocating linear motion mechanism.

Fig. 7 is a perspective view showing an example of the cup holder drive mechanism.

Fig. 8 is a perspective view showing a frame for a drive mechanism according to the second embodiment of the present invention.

Fig. 9 is a perspective view showing the frame for a

drive mechanism in a state in which the reciprocating linear motion mechanism and the cup holder drive mechanism (a cam mechanism) are fixed.

5 DETAILED DESCRIPTION OF THE INVENTION

<First embodiment>

[0047] A can body maker 101 of a first embodiment of the present invention will be described with reference to the drawings.

[0048] As shown in Fig. 1, the can body maker 101 of the present embodiment is a DI can manufacturing apparatus in which a cup-shaped body W which is a work-piece is subjected to DI processing to obtain a DI can 1100.

[0049] First, the DI can 1100 will be described.

[0050] The DI can 1100 has a bottomed tubular shape. The DI can 1100 is used for a can body such as a two-piece can or a bottle can which is filled with contents such as beverages and sealed. In the case of the two-piece can, the can body includes the DI can 1100 and a can lid in a disc shape which is wound around and fastened to an opening end portion of the DI can 1100. In the case of the bottle can, the can body includes a bottle can body obtained by subjecting the DI can 1100 to necking processing, screw processing, or the like, and a cap which is screwed to the opening end portion of the bottle can body.

[0051] The DI can 1100 is formed in a bottomed tubular shape by a blank in a disc shape obtained by punching a plate material such as a material formed of an aluminum alloy being subjected to a cupping process (a drawing process) and a DI process (a drawing and ironing process). Specifically, in the case of the two-piece can, for example, the DI can 1100 is manufactured through a plate material punching process, a cupping process, a DI process, a trimming process, a printing process, an inner surface coating process, a necking process, and a flanging process in that order.

[0052] In the process of manufacturing the DI can 1100, the blank is subjected to drawing processing (cupping processing) by a cupping press and is formed into the cup-shaped body W. That is, the cup-shaped body W is an intermediate formed body manufactured in the process of transitioning from the blank to the DI can 1100 in the cupping process. The cup-shaped body W is in a bottomed tubular shape having a circumferential wall height (a length in a can axial direction) smaller than that of the DI can 1100 and a diameter larger than that of the DI can 1100.

[0053] Next, the can body maker 101 will be described.

[0054] The can body maker 101 is used in the DI process. The can body maker 101 performs DI processing, that is, drawing (re-drawing) and ironing processing, on the cup-shaped body W to form the DI can 1100 having a circumferential wall height larger than that of the cup-shaped body W and a diameter smaller than that of the

cup-shaped body W. Further, in the above DI process, the can body maker 101 forms the can bottom of the DI can 1100 into a dome shape. That is, in the present embodiment, the can 1100 formed by the can body maker 101 is the DI can 1100.

[0055] The can body maker 101 includes a ram shaft 103 extending in an axial direction centered on a central axis O, a punch 102, a reciprocating linear motion mechanism 104, a bearing unit 150, a die 108 having a through hole 107 into which the punch 102 is inserted, a cup holding mechanism (a cup holder) 130 having a cup holder sleeve 131 which presses the cup-shaped body W against an end face 109 in which the through hole 107 of the die 108 opens, a cup holder drive mechanism 110, a gear 120, and a dome former 106 that sandwiches the can bottom of the DI can 1100 between the punch 102 and the dome former to form the can bottom of the DI can 1100 into a dome shape.

[0056] The central axes O of the ram shaft 103, the punch 102, the bearing unit 150, the through hole 107 of the die 108, the cup holder sleeve 131, and the dome former 106 are disposed coaxially with each other. In the present embodiment, the central axis O which is a common axis of these members extends in a horizontal direction.

[0057] Further, the can body maker 101 includes a cup feeder (not shown) which supplies the cup-shaped body W on the end face 109 of the die 108, a receiving seat (not shown) which holds the cup-shaped body W on the end face 109, a can transport mechanism (not shown) which transports the formed DI can 1100 to the outside of the machine, an air discharge mechanism (not shown) which discharges air from an air discharge hole that opens in at least any of a tip end face and an outer circumferential surface of the punch 102 to separate the DI can 1100 from the punch 102, a drive source (not shown) such as a drive motor, and a device frame (a frame for a drive mechanism) that appropriately supports each of the above-described constituent elements of the can body maker 101.

[0058] In the present embodiment, a direction in which the central axis O extends (an X-axis direction) is referred to as a front-rear direction. That is, in an XYZ orthogonal coordinate system shown in each drawing, the front-rear direction corresponds to the X-axis direction. The front-rear direction is a predetermined direction among horizontal directions. In the front-rear direction, the die 108 and the reciprocating linear motion mechanism 104 are disposed at different positions from each other. In the front-rear direction, a direction from the reciprocating linear motion mechanism 104 toward the die 108 (a -X side) is referred to as a front side, and a direction from the die 108 toward the reciprocating linear motion mechanism 104 (a +X side) is referred to as a rear side. The front-rear direction may also be called an axial direction. In this case, the front side is one side in the axial direction, and the rear side is another side in the axial direction.

[0059] Among directions orthogonal to the front-rear

direction, a vertical direction (a Z-axis direction) is referred to as an up-down direction. In each drawing, a +Z side is an upper side and a -Z side is a lower side.

[0060] A direction orthogonal to the front-rear direction among the horizontal directions, that is, a direction orthogonal to the front-rear direction and the up-down direction (a Y-axis direction), is referred to as a left-right direction. In each drawing, the +Y side is a right side and the -Y side is a left side.

[0061] The ram shaft 103 has a shaft shape extending in the front-rear direction. The ram shaft 103 is supported by the bearing unit 150 to be slidable in the front-rear direction.

[0062] The punch 102 is disposed at a front end portion of the ram shaft 103. The punch 102 has a cylindrical or columnar shape and extends in the front-rear direction.

[0063] The reciprocating linear motion mechanism 104 has a ram shaft connecting portion 104a. The reciprocating linear motion mechanism 104 converts a rotational driving force around a rotation axis C which is input from a drive source (not shown) into a reciprocating linear motion in the front-rear direction and outputs the reciprocating linear motion to the ram shaft connecting portion 104a. The ram shaft connecting portion 104a is connected to a rear end portion of the ram shaft 103. That is, the reciprocating linear motion mechanism 104 is connected to the rear end portion of the ram shaft 103 to reciprocate and linearly move the ram shaft 103 in the front-rear direction.

[0064] The bearing unit 150 is disposed between the reciprocating linear motion mechanism 104 and the die 108 in the front-rear direction. As shown in Figs. 2 and 3, the bearing unit 150 has a tubular shape extending in the front-rear direction. The bearing unit 150 includes a bearing 105 that supports the ram shaft 103 to be slidable in the front-rear direction. That is, the can body maker 101 includes a bearing 105. A pair of bearings 105 are provided at intervals in the front-rear direction. The pair of bearings 105 are integrally formed with the bearing unit 150. Of the pair of bearings 105, one bearing 105 located on the front side is a front bearing 105F, and another bearing 105 located on the rear side is a rear bearing 105R. The front bearing 105F and the rear bearing 105R have a structure of a fluid bearing that is called, for example, a hydrodynamic bearing or a hydrostatic bearing.

[0065] As shown in Fig. 1, a plurality of dies 108 are provided side by side in the front-rear direction. Each of the plurality of dies 108 has a through hole 107 having a circular cross section which penetrates the die 108 in the front-rear direction. The plurality of dies 108 have one redrawing die 108A and a plurality of ironing dies 108B located on the front side of the redrawing die 108A. Although not separately shown, a pilot ring is disposed on the front side of each ironing die 108B. By the pilot ring being provided, it is possible to prevent the punch 102 from coming into contact with each ironing die 108B due to the impact when the DI can 1100 is removed from

(passed through) each ironing die 108B during forming.

[0066] Further, at the time of forming, a coolant liquid is supplied to the redrawing die 108A and each ironing die 108B for lubrication and cooling.

[0067] As shown in Figs. 2 and 3, the cup holding mechanism 130 has the cup holder sleeve 131, a pair of rods 132 connected to a pair of arms 115 of the cup holder drive mechanism 110 which will be described later, and a biasing unit 133 which is provided between the cup holder sleeve 131 and the pair of rods 132 and allows the cup holder sleeve 131 to be biased forward with air pressure.

[0068] The cup holder sleeve 131 has a cylindrical shape extending in the front-rear direction. As shown in Fig. 1, the punch 102 and the ram shaft 103 are inserted into the cup holder sleeve 131 in the front-rear direction. The cup holder sleeve 131, the punch 102, and the ram shaft 103 are relatively slidable in the front-rear direction. The cup holder sleeve 131 can press a bottom wall of the cup-shaped body W against the end face 109 facing the rear side of the redrawing die 108A. The cup holder sleeve 131 is inserted into the cup-shaped body W disposed on the end face 109 of the die 108 and presses the bottom wall of the cup-shaped body W against the end face 109 for support.

[0069] As shown in Figs. 1 to 3, the pair of rods 132 are disposed on both sides of the ram shaft 103 in the left-right direction with the ram shaft 103 sandwiched therebetween. Each rod 132 extends in the front-rear direction. In the present embodiment, a front side portion including at least the front bearing 105F of the bearing unit 150 is located between the pair of rods 132.

[0070] The pair of rods 132 are connected in the direction perpendicular to the front-rear direction (the left-right direction) through the rod connecting bar 134. It is possible to prevent one rod 132 from being displaced in front-rear direction and/or twisted around the axis independently from the other rod 132 by the pair of rods 132 being connected by the rod connecting bar 132. As a result, the cup can be held precisely at a high level.

[0071] The rod connecting bar 134 may be provided on the upper side of the rods 132 (the opposite side of the cam structure described later) as shown in Figs. 2 and 3. Alternatively, the rod connecting bar 134 may be provided on the lower side of the rods 132 (the side of the cam structure described later) unlike the embodiment shown in Figs. 2 and 3.

[0072] In the case where the rod connecting bar 134 is provided on the upper side, the bottom surface of the rod connecting bar 134 is in a concave shape that recesses toward the upper side. The concave shape may be composed of only a curved line, only a straight line, or a combination of a curved line and a straight line.

[0073] In the case where the rod connecting bar 134 is provided on the lower side, the upper surface of the rod connecting bar 134 is in a concave shape that recesses toward the lower side. The concave shape may be composed of only a curved line, only a straight line,

or a combination of a curved line and a straight line.

[0074] In either case, the distance along the lower or upper surface in the concave shape in the left-right direction is longer than the minimum distance between the pair of rods 132.

[0075] Since the bottom surface or the upper surface of the rod connecting bar 134 has the concave shape, the rod connecting bar 134 connects the pair of rods 132 in such a way that the rod connecting bar 134 avoids the space occupying the center between the pair of rods 132 and detours the ram shaft 103 and the front bearing 105F. In other words, the rod connecting bar 134 does not interfere with the space that occupies the center between the pair of rods 132.

[0076] The can body maker can be configured in such a way that the central axis O passes the center between the pair of rods 132, while independent displacement/twist between the pair of rods 132 being suppressed by having the pair of rods 132 connected by the rod connecting bar 134 with the bottom/upper surface in the concave shape. As a result, the can bodies can be made with high accuracy.

[0077] The rod 132 has a rod body 132a and a roller follower (a roller) 132b.

[0078] The rod body 132a has a shaft shape or a tubular shape and extends in the front-rear direction. The rod bodies 132a of the pair of rods 132 are parallel to each other. The rod body 132a is supported by, for example, a ball spline or a dry bearing to be slidable in the front-rear direction.

[0079] The roller follower 132b is connected to the rod body 132a via the left-right end of the rod connecting bar 134.

[0080] The roller follower 132b projects from the rod body 132a in the left-right direction. The roller follower 132b is rotatable around a roller follower axis extending in the left-right direction and is supported by the rod body 132a through the rod connecting bar 134. An arm 115 which will be described later is connected to the roller follower 132b.

[0081] The biasing unit 133 has a substantially cylindrical shape. The punch 102 and the ram shaft 103 are inserted into the biasing unit 133 in the front-rear direction. The biasing unit 133, the punch 102, and the ram shaft 103 are relatively slidable in the front-rear direction.

[0082] As shown in Figs. 2 and 3, the biasing unit 133 includes a rod attachment portion 133a, a cup holder sleeve attachment portion 133b, and an airbag 133c.

[0083] The rod attachment portion 133a is a cylindrical housing centered on the central axis O. The rod attachment portion 133a is attached to the rod 132. A rear wall of the rod attachment portion 133a is fixed to a front end portion of the rod body 132a.

[0084] The cup holder sleeve attachment portion 133b has an annular plate shape centered on the central axis O. The cup holder sleeve attachment portion 133b is disposed on the front side of the rod attachment portion 133a. The cup holder sleeve attachment portion 133b is

attached to a rear end portion of the cup holder sleeve 131. The cup holder sleeve attachment portion 133b and the cup holder sleeve 131 can be slidably moved in the front-rear direction with respect to the rod attachment portion 133a.

[0085] The airbag 133c is an annular shape centered on the central axis O. The airbag 133c is sandwiched between a rear wall of the rod attachment portion 133a and the cup holder sleeve attachment portion 133b in the front-rear direction. The airbag 133c can internally hold the air supplied from an air supply means (not shown). The airbag 133c is made of rubber, for example, and is elastically deformable.

[0086] When the rod attachment portion 133a is pushed toward the front side by the rod 132 that moves back and forth, the biasing unit 133 biases the cup holder sleeve 131 toward the front side via the airbag 133c and the cup holder sleeve attachment portion 133b. That is, the biasing unit 133 biases the cup holder sleeve 131 forward with air pressure and an elastic restoring force of the airbag 133c. Accordingly, the cup-shaped body W is held by the cup holder sleeve 131 in a state of being pressed against the end face 109 of the die 108 to be in close contact therewith.

[0087] As shown in Fig. 1, the cup holder drive mechanism 110 oscillates the cup holding mechanism 130 in the front-rear direction. Specifically, the cup holder drive mechanism 110 converts the rotational driving force transmitted from a drive source (not shown) via the reciprocating linear motion mechanism 104 and the gear 120 into a reciprocating motion in the front-rear direction and transmits the reciprocating motion to the cup holding mechanism 130. Accordingly, the cup holder drive mechanism 110 has a stroke length different from that of the ram shaft connecting portion 104a and reciprocates and linearly moves the cup holding mechanism 130 in the front-rear direction to be synchronized with the back and forth movement of the ram shaft connecting portion 104a.

[0088] The cup holder drive mechanism 110 has a cam structure synchronized with the reciprocating linear motion mechanism 104. The cup holder drive mechanism 110 is disposed directly below the cup holding mechanism 130. Specifically, the cup holder drive mechanism 110 is disposed adjacent to a lower side of at least a part of the rod 132 of the cup holding mechanism 130. When seen in the up-down direction, the cup holding mechanism 130 and the cup holder drive mechanism 110 overlap each other. The cup holder drive mechanism 110 is disposed directly below the bearing unit 150. That is, the cup holder drive mechanism 110 is disposed directly below the bearing 105. When seen in the up-down direction, the bearing 105 (the bearing unit 150) and the cup holder drive mechanism 110 overlap each other. In the present embodiment, "overlapping each other (when seen in a certain direction)" means that two members are disposed such that at least a part of one member overlaps at least a part of another member when seen in a certain direction such as the up-down direction, for example.

[0089] As shown in Figs. 2 and 3, the cup holder drive mechanism 110 has a cam shaft 111 centered on a first central axis J1 extending in the left-right direction, a cam 112, an oscillation shaft 113 centered on a second central axis J2 parallel to the first central axis J1, an oscillation unit 114, and a pair of arms 115.

[0090] The first central axis J1 and the second central axis J2 are disposed apart from each other. In the present embodiment, the second central axis J2 is located on the front side and the upper side of the first central axis J1. Each of an axial direction in which the first central axis J1 extends and an axial direction in which the second central axis J2 extends corresponds to the left-right direction.

[0091] In the following description, a direction orthogonal to the first central axis J1 is referred to as a first radial direction (a radial direction). In the first radial direction, a direction closer to the first central axis J1 is referred to as an inner side in the first radial direction, and a direction away from the first central axis J1 is referred to an outer side in the first radial direction.

[0092] A direction of orbiting around the first central axis J1 is referred to as a first circumferential direction.

[0093] A direction orthogonal to the second central axis J2 is referred to as a second radial direction (a radial direction). In the second radial direction, a direction closer to the second central axis J2 is referred to as an inner side in the second radial direction, and a direction away from the second central axis J2 is referred to an outer side in the second radial direction.

[0094] A direction of orbiting around the second central axis J2 is referred to as a second circumferential direction.

[0095] As shown in Fig. 2, the cam shaft 111 has a shaft shape or a tubular shape and extends in the left-right direction. Although not particularly shown, the cam shaft 111 is supported by bearings held in the device frame to be rotatable in the first circumferential direction. Although not particularly shown, the cam shaft 111 is supported by a front plate and a back plate of the device frame (the frame for a drive mechanism) via bearings.

[0096] The cam 112 is fixed to an outer circumferential portion of the cam shaft 111. The cam 112 is rotated around the first central axis J1 together with the cam shaft 111. As shown in Fig. 3, the cam 112 has a plate shape extending in a direction perpendicular to the first central axis J1. An outer circumferential surface of the cam 112 facing the outer side in the first radial direction has different positions in the first radial direction in respective portions in the first circumferential direction. A distance in the first radial direction from the first central axis J1 to the outer circumferential surface of the cam 112 gradually changes in the first circumferential direction.

[0097] A pair of cams 112 are provided at intervals in the left-right direction. The pair of cams 112 are disposed on both sides of the central axis O in the left-right direction with the central axis O sandwiched therebetween when seen in the up-down direction. Of the pair of cams 112,

one cam 112 located on the right side (the +Y side) of the central axis O is a forward cam 112A, and another cam 112 located on the left side (-Y side) of the central axis O is a backward cam 112B. The forward cam 112A and the backward cam 112B are disposed such that their angular positions, that is, their phases around the first central axis J1, are different from each other. The forward cam 112A and the backward cam 112B are preferably common products (same members) having the same shape.

[0098] The oscillation shaft 113 has a shaft shape or a tubular shape and extends in the left-right direction. The oscillation shaft 113 is supported by a bearing 119 held in the device frame (not shown) to be rotatable in the second circumferential direction. Although not particularly shown, the oscillation shaft 113 is supported by the front plate and the back plate of the device frame (the frame for a drive mechanism) via the bearing 119.

[0099] The oscillation unit 114 is fixed to an outer circumferential portion of the oscillation shaft 113. As shown in Fig. 4C, the oscillation unit 114 is oscillated (rotated) around the second central axis J2 together with the oscillation shaft 113 by being in contact with the cam 112. The oscillation unit 114 has an oscillation plate 114a and a cam follower 125.

[0100] The oscillation plate 114a is attached to the outer circumferential portion of the oscillation shaft 113. As shown in Fig. 2, the oscillation plate 114a has a plate shape extending in a direction perpendicular to the second central axis J2. The oscillation plate 114a overlaps the central axis O when seen in the up-down direction. As shown in Fig. 4C, in the present embodiment, the oscillation plate 114a has a substantially V shape when seen in the left-right direction. The oscillation plate 114a has a pair of protrusions 114b disposed apart from each other in the second circumferential direction. Each protrusion 114b protrudes toward the outer side in the second radial direction.

[0101] As shown in Fig. 3, the cam follower 125 projects from the oscillation plate 114a in the left-right direction. The cam follower 125 is rotatable around a cam follower axis extending in the left-right direction and is supported by the oscillation plate 114a. An outer circumferential surface of the cam follower 125 is in contact with the outer circumferential surface of the cam 112.

[0102] A pair of cam followers 125 are provided on a surface of the oscillation plate 114a facing the right side (+Y side) and a surface of the oscillation plate 114a facing the left side (-Y side). The pair of cam followers 125 are disposed on both sides of the central axis O in the left-right direction with the central axis O sandwiched therebetween when seen in the up-down direction. Of the pair of cam followers 125, one cam follower 125 projecting from the surface of the oscillation plate 114a facing the right side is a forward cam follower 125A, and another cam follower 125 projecting from the surface of the oscillation plate 114a facing the left side is a backward cam follower 125B.

[0103] As shown in Fig. 4C, the forward cam follower 125A and the backward cam follower 125B are disposed at different positions in the second circumferential direction. The forward cam follower 125A protrudes to the right side from one protrusion 114b of the pair of protrusions 114b, which is located on the upper side. The backward cam follower 125B protrudes to the left side from another protrusion 114b of the pair of protrusions 114b, which is located on the lower side. Specifically, the forward cam follower 125A is located above a virtual straight line (not shown) passing through the first central axis J1 and the second central axis J2 when seen in the left-right direction. The backward cam follower 125B is located below the virtual straight line when seen in the left-right direction.

[0104] An outer circumferential surface of the forward cam follower 125A is in contact with an outer circumferential surface of the forward cam 112A. An outer circumferential surface of the backward cam follower 125B is in contact with an outer circumferential surface of the backward cam 112B.

[0105] As shown in Figs. 2 and 3, the arm 115 is fixed to the outer circumferential portion of the oscillation shaft 113. The arm 115 has a plate shape extending in a direction perpendicular to the second central axis J2. The arm 115 protrudes toward the upper side from the oscillation shaft 113. The arm 115 extends in the up-down direction. The arm 115 is oscillated (rotated) around the second central axis J2 together with the oscillation shaft 113.

[0106] The pair of arms 115 are disposed on both sides of the ram shaft 103 in the left-right direction with the ram shaft 103 sandwiched therebetween (see Fig. 1). That is, the pair of arms 115 are disposed on both sides of the ram shaft 103 when seen in the up-down direction. The pair of arms 115 are disposed on both sides of the oscillation unit 114 in the left-right direction with the oscillation unit 114 sandwiched therebetween. In other words, the ram shaft 103 and the oscillation unit 114 are located between the pair of arms 115 in the left-right direction. A distance in the left-right direction between one arm 115 of the pair of arms 115 which is located on the right side and the oscillation plate 114a is the same as a distance in the left-right direction between another arm 115 of the pair of arms 115 which is located on the left side and the oscillation plate 114a. That is, the oscillation unit 114 is disposed at the same distance from the pair of arms 115 in the left-right direction.

[0107] As shown in Fig. 4C, an upper end portion of the arm 115 is connected to the roller follower 132b. Specifically, a U-shaped recess that penetrates the arm 115 in the left-right direction and opens toward the upper side is formed in the upper end portion of the arm 115, and a roller follower 132b is disposed in the recess to be sandwiched in the front-rear direction. The arm 115 reciprocates and linearly moves the cup holding mechanism 130 in the front-rear direction via the roller follower 132b. That is, the pair of arms 115 oscillate around the second cen-

tral axis J2 together with the oscillation unit 114 and the oscillation shaft 113 to move the cup holding mechanism 130 back and forth.

[0108] Specifically, as shown in Figs. 4A to 4C, when the cam 112 rotates around the first central axis J1, the distance in the first radial direction from the first central axis J1 to the outer circumferential surface of the cam 112 changes in the first circumferential direction, and thus the position of the cam follower 125 in contact with the cam 112 around the second central axis J2 changes, and the oscillation unit 114, the oscillation shaft 113, and the pair of arms 115 rotate in the second circumferential direction.

[0109] More specifically, when the forward cam 112A rotates in the first circumferential direction from the state shown in Fig. 4A, a distance in the first radial direction between a contact portion between the forward cam 112A and the forward cam follower 125A and the first central axis J1 gradually increases, and thus the forward cam follower 125A rotates in a predetermined direction (counterclockwise in Fig. 4A) around the second central axis J2, and accordingly, the oscillation unit 114, the oscillation shaft 113, and the pair of arms 115 rotate in the predetermined direction around the second central axis J2.

[0110] As a result, the pair of arms 115 move the cup holding mechanism 130 toward the front side via the roller followers 132b in the order shown in Figs. 4B and 4C.

[0111] Further, when the backward cam 112B rotates in the first circumferential direction from the state shown in Fig. 4C, a distance in the first radial direction between a contact portion between the backward cam 112B and the backward cam follower 125B and the first central axis J1 gradually increases, and thus the backward cam follower 125B rotates in a direction opposite to the predetermined direction (clockwise in Fig. 4C) around the second central axis J2, and accordingly, the oscillation unit 114, the oscillation shaft 113, and the pair of arms 115 rotate in a direction opposite to the predetermined direction around the second central axis J2.

[0112] As a result, as shown in Fig. 4A, the pair of arms 115 move the cup holding mechanism 130 toward the rear side via the roller followers 132b.

[0113] As shown in Figs. 2 and 3, in the present embodiment, each of the pair of arms 115 has a cover 115a. The cover 115a is detachably provided on the upper end portion of the arm 115. The cover 115a covers the recess of the arm 115 and the roller follower 132b in the left-right direction.

[0114] As shown in Fig. 2, the gear 120 transmits the rotational driving force around the rotation axis C of the reciprocating linear motion mechanism 104 to the cup holder drive mechanism 110. A plurality of gears 120 are provided. The plurality of gears 120 have a first gear 121 attached to the reciprocating linear motion mechanism 104, a second gear 122 attached to the cup holder drive mechanism 110, and a third gear 123 that meshes with the first gear 121 and the second gear 122.

[0115] The first gear 121 has an annular plate shape centered on the rotation axis C. The first gear 121 outputs the rotational driving force around the rotation axis C of the reciprocating linear motion mechanism 104 to the outside of the reciprocating linear motion mechanism 104.

[0116] The second gear 122 has an annular plate shape centered on the first central axis J1 parallel to the rotation axis C. The second gear 122 is fixed to an end portion (a right end portion) of the cam shaft 111 in the left-right direction.

[0117] The number of teeth of the first gear 121 and the number of teeth of the second gear 122 are the same. As a result, the reciprocating linear motion mechanism 104 and the cup holder drive mechanism 110 can operate in synchronization with each other.

[0118] The third gear 123 is disposed between the first gear 121 and the second gear 122. The third gear 123 has an annular plate shape centered on a third gear axis (not shown) extending in the left-right direction. In the illustrated example, an outer diameter of the third gear 123 is smaller than an outer diameter of each of the first gear 121 and the second gear 122. The number of teeth of the third gear 123 is smaller than the number of teeth of each of the first gear 121 and the second gear 122.

[0119] As shown in Fig. 1, the dome former 106 is a tooling for forming the can bottom of the DI can 1100. The dome former 106 has a substantially cylindrical shape extending in the front-rear direction. When the punch 102 is disposed at a forward end position in the front-rear direction, the dome former 106 faces the punch 102 in the front-rear direction.

[0120] The DI processing of the cup-shaped body W by the can body maker 101 of the present embodiment is performed as follows.

[0121] First, the cup-shaped body W which is a workpiece is disposed between the punch 102 and the redrawing die 108A in a posture in which a cup axis (a can axis) extends in the front-rear direction and the opening of the cup-shaped body W is directed to the rear side. The bottom wall of the cup-shaped body W faces the end face 109 of the redrawing die 108A.

[0122] The cup holder sleeve 131 of the cup holding mechanism 130 and the punch 102 are moved forward with respect to the cup-shaped body W. Then, while the cup holder sleeve 131 presses the bottom wall of the cup-shaped body W against the end face 109 of the redrawing die 108A to perform a cup pressing operation, the punch 102 pushes the cup-shaped body W into the through hole 107 of the redrawing die 108A, and thus the cup-shaped body W is subjected to redrawing processing.

[0123] By the redrawing processing, the cup-shaped body W is formed to have a small diameter and has a large length in a cup axial direction (that is, the front-rear direction). The ironing processing is performed while the cup-shaped body W is further pushed in by the punch 102 and is sequentially passed through the through holes

107 of the plurality of ironing dies 108B. That is, the circumferential wall of the cup-shaped body W is ironed and stretched to increase a height of the circumferential wall and reduce a thickness of the circumferential wall and thus a DI can 1100 having a bottomed tubular shape is formed. The DI can 1100 is cold-work-hardened by the circumferential wall being ironed to have an increased strength.

[0124] The DI can 1100 subjected to the ironing processing is extruded toward the front side from the through hole 107 of the die 108 by the punch 102. Then, a bottom portion of the DI can 1100 (a portion that becomes the can bottom) is sandwiched and pressed between the punch 102 and the dome former 106, and thus the bottom portion of the DI can 1100 is formed into a dome shape.

[0125] In the can body maker 101 of the present embodiment described above, since the cup holder drive mechanism 110 has a cam structure, it is easy to synchronize the reciprocating linear motion mechanism 104 that moves the ram shaft 103 back and forth with the cup holder drive mechanism 110. Since the cup holder drive mechanism 110 is disposed directly below the cup holding mechanism 130, a distance between these mechanisms 110 and 130 can be suppressed to be short. To connect the cup holder drive mechanism 110 and the cup holding mechanism 130, it is not necessary to continuously provide a plurality of shafts between the mechanisms 110 and 130 or to use a joint member or the like as in the related art. According to the present embodiment, the number of the components can be reduced and the manufacturing cost can be reduced. Further, the size of the member connecting the cup holder drive mechanism 110 and the cup holding mechanism 130 can be suppressed to be small.

[0126] According to the present embodiment, it is possible to suppress the occurrence of loss in the force transmitted from the cup holder drive mechanism 110 to the cup holding mechanism 130. The power for driving the cup holder drive mechanism 110 can be reduced, resulting in a reduction in energy. Further, it is easy to equalize a load acting on each member that connects the cup holder drive mechanism 110 and the cup holding mechanism 130, and it is possible to suppress the occurrence of variation in component life of each member, and as a result, to extend the component life. Since the cup holding mechanism 130 which is moved back and forth by the cup holder drive mechanism 110 stably presses the cup-shaped body W against the end face 109 of the die 108, the forming accuracy of the DI can 1100 is well maintained. The structure of the can body maker 101 is simplified, and an outer shape thereof can be kept to be compact.

[0127] According to the present embodiment, it is possible to improve the forming accuracy of the can 1100, to suppress the occurrence of a defective can, and to improve the production efficiency of the can 1100.

[0128] Further, in the present embodiment, the can

body maker 101 includes the gear 120 that transmits the rotational driving force around the rotation axis C of the reciprocating linear motion mechanism 104 to the cup holder drive mechanism 110.

[0129] In this case, loss in the power transmission is suppressed to be smaller than that in the configuration in which the rotational driving force of the reciprocating linear motion mechanism 104 is transmitted to the cup holder drive mechanism 110 via, for example, a belt or the like. In addition, the can body maker 101 can be configured more compactly.

[0130] Further, in the present embodiment, the rotation around the first central axis J1 which is input to the cup holder drive mechanism 110 is converted into the oscillation around the second central axis J2 by the cam 112, the oscillation unit 114, and the like, and the oscillation is output from the pair of arms 115. The pair of arms 115 are disposed on both sides of the ram shaft 103 in the left-right direction and act evenly on the cup holding mechanism 130. As a result, the cup holding mechanism 130 stably presses the cup-shaped body W against the end face 109 of the die 108, and the forming accuracy of the DI can 1100 is stably ensured.

[0131] Further, in the present embodiment, the cup holding mechanism 130 biases the cup holder sleeve 131 forward by the biasing unit 133 with the air pressure and the elastic restoring force, and thus pressure (cup holding pressure) with which the cup holder sleeve 131 presses the cup-shaped body W against the end face 109 of the die 108 is stabilized from the initial stage of the operation of the machine. Further, according to the present embodiment, the cup holding pressure is easily adjusted as compared with the case in which the cup holder sleeve 131 is biased forward with, for example, hydraulic pressure unlike the case of the present embodiment.

[0132] Further, in the present embodiment, the cup holder drive mechanism 110 is disposed directly below the bearing 105 (the bearing unit 150).

[0133] In this case, since the cup holding mechanism 130, the bearing 105, and the cup holder drive mechanism 110 are disposed adjacent to each other in the up-down direction, the can body maker 101 can be configured more compactly.

[0134] Further, in the present embodiment, the pair of bearings 105 of the bearing unit 150 are integrally formed.

[0135] In this case, the pair of bearings 105, that is, the front bearing 105F and the rear bearing 105R, can be easily aligned, and the centering work at the time of assembly or the like can be omitted or simplified. Since the straightness of the ram shaft 103 is maintained well, the forming accuracy of the DI can 1100 is stably ensured.

[0136] The present invention is not limited to the above-described embodiment, and the configuration can be changed without departing from the gist of the present invention, for example, as will be described below.

[0137] The cam structure included in the cup holder drive mechanism 110 is not limited to the configuration

described in the above-described embodiment. For example, the shape of the cam 112, the disposition of the cam followers 125, the respective numbers of the cams 112 and the cam followers 125, the shape of the oscillation unit 114, and the like may be different from the above-described embodiment.

[0138] In the present invention, respective configurations which are described in the above-described first embodiment, the second embodiment which will be described later, a modification example, and the like may be combined with each other, and addition, omission, and replacement of a configuration, other changes, and the like are possible without departing from the gist of the present invention. Further, the present invention is not limited to the embodiments and the like, but is limited to only the claims.

<Second embodiment>

[0139] Hereinafter, the frame for a drive mechanism 210 according to the second embodiment to which the present invention is applied, a can body maker 2100 provided with the same, and a drive mechanism of the can body maker 2100 will be described with reference to the drawings. The embodiments which will be shown below are specifically described to better understand the gist of the invention and do not limit the present invention unless otherwise specified. In addition, the drawings which will be used in the following description may be shown with the main parts being enlarged for convenience to make the features of the present invention easy to understand, and the size ratios of the respective components are not always the same as the actual ones.

[0140] First, a DI can which is made from a cup-shaped body W will be described.

[0141] The DI can is used for a can body (a two-piece can or a bottle can) which is filled with contents such as beverages and sealed. In the case of the two-piece can, the can body includes a DI can in a bottomed tubular shape and a can lid in a disc shape which is wound around and fastened to an opening end portion of the DI can. In the case of a bottle can, the can body includes a DI can subjected to so-called die necking processing referred to as bottle necking and the like after DI processing and a cap that is screwed to an opening end portion of the DI can. The "DI" of the DI can is an abbreviation for drawing and ironing.

[0142] The DI can is formed in a bottomed tubular shape by a blank in a disc shape obtained by punching a plate material formed of an aluminum alloy material being subjected to a cupping process (a drawing process) and a DI process (a drawing and ironing process). Specifically, in the case of the two-piece can, for example, the DI can is manufactured through a plate material punching process, a cupping process, a DI process, a trimming process, a printing process, a coating process, a necking process, a bottom reforming process, and a flanging process in that order.

[0143] Next, the can body maker 2100 will be described.

[0144] Fig. 5 is a schematic configuration view showing an example of the can body maker 2100.

[0145] In Fig. 5, the can body maker 2100 is used in the DI process described above, and the cup-shaped body W is subjected to the DI processing (drawing (re-drawing) and ironing processing) to form a DI can U. That is, in the present embodiment, the can U formed by the can body maker 2100 is the DI can U. The can body maker 2100 includes a ram shaft 2103 provided with a punch sleeve (a punch) 2102 at a front end portion, a reciprocating linear motion mechanism (a ram shaft drive mechanism) 211 that reciprocates the ram shaft 2103 in an axis O direction of the ram shaft 2103, a bearing 2105 (2105F, 2105R) that supports the ram shaft 2103 to be reciprocated in the axis O direction, a die 2108 (2108A, 2108B) having a through hole 2107 through which the punch sleeve 2102 is inserted, a cup holding mechanism 2101 including a cup holder 2106 that is inserted into the cup-shaped body W disposed on an end face 2108a facing rearward in the axis O direction of the die 2108 and presses the bottom wall of the cup-shaped body W toward the end face 2108a, and a biasing means 2115 which is located behind the bearing 2105 (a front bearing 2105F) in the axis O direction and is capable of biasing the cup holder 2106 with air pressure.

[0146] Further, the can body maker 2100 includes a cup feeder (not shown) which transports the cup-shaped body W on the end face 2108a of the die 2108, a receiving seat (not shown) which holds the cup-shaped body W on the end face 2108a, a bottom former (a can bottom forming tooling) 2110 which faces the punch sleeve 2102 in the axis O direction and is disposed at a forward end position of the punch sleeve 2102 in the axis O direction to form the can bottom together with the punch sleeve 2102, a can transport mechanism (not shown) which transports the formed DI can U to the outside of the can body maker 2100, a blower (an air discharge mechanism) 2112 which discharges air from an air discharge hole that opens in a front end of the punch sleeve 2102 to separate the DI can U from the punch sleeve 2102, a cup holder drive mechanism (a cam mechanism) 212 which is mechanically connected to the reciprocating linear motion mechanism 211 to be driven in synchronization therewith and reciprocates the cup holder 2106 of the cup holding mechanism 2101 in the axis O direction, and a drive source (not shown) such as a drive motor which is connected to the reciprocating linear motion mechanism 211.

[0147] Then, the can body maker 2100 is provided with a frame for a drive mechanism 210 including a frame base 210A to which the reciprocating linear motion mechanism 211 and the cup holder drive mechanism (the cam mechanism) 212 are fixed and an extension portion 210B on which the die 2108 and the bottom former (the can bottom forming tooling) 2110 are placed.

[0148] The central axes of the ram shaft 2103, the punch sleeve 2102, the bearing 2105, the die 2108, the

cup holder 2106, and bottom former 2110 are disposed coaxially with each other and extend in the horizontal direction. In the present embodiment, this common axis is referred to as axis O.

[0149] Next, the reciprocating linear motion mechanism (the ram shaft drive mechanism) 211 will be described.

[0150] Fig. 6 is a perspective view showing an example of the reciprocating linear motion mechanism 211.

[0151] The reciprocating linear motion mechanism 211 includes a housing 221 having an internal gear 223, a first rotating body (a rotating shaft) 222, a second rotating body 224 having an external gear 225 that meshes with the internal gear 223, and a ram shaft connecting portion (an acting portion) 227.

[0152] The housing 221, the internal gear 223 thereof, and the first rotating body (the rotating shaft) 222 are centered on the first central axis C1, that is, are disposed coaxially with each other with the first central axis C1 as a common axis. The second rotating body 224 and the external gear 225 thereof are centered on the second central axis C2, that is, are disposed coaxially with each other with the second central axis C2 as a common axis.

[0153] The first central axis C1 and the second central axis C2 are disposed parallel to each other and apart from each other. In the present embodiment, the first central axis C1 and the second central axis C2 extend in the horizontal direction.

[0154] An outer shape of the housing 221 is a cylindrical shape. The cylindrical shape referred to here includes not only a cylindrical shape having a perfect circular cross section but also a cylindrical shape having a flat in a part thereof or having protrusions or ridges formed on an outer circumferential surface thereof.

[0155] The first rotating body (the rotating shaft) 222 of the reciprocating linear motion mechanism 211 is connected to the rotating shaft of a motor (not shown) which is a drive source of the reciprocating linear motion mechanism 211.

[0156] In such a reciprocating linear motion mechanism 211, when a rotational driving force is transmitted from a motor (not shown) to the first rotating body (the rotating shaft) 222, the first rotating body (the rotating shaft) 222 is rotated around the first central axis C1. Then, the second rotating body 224 supported by the first rotating body 222 is also rotated around the first central axis C1.

[0157] At this time, since the external gear 225 of the second rotating body 224 and the internal gear 223 of the housing 221 mesh with each other, the second rotating body 224 is rotated (revolved) around the first central axis C1 and is also rotated (autorotated) around the second central axis C2. Then, the ram shaft connecting portion (the acting portion) 227 connected to the second rotating body 224 reciprocates and linearly moves in a horizontal axis S1 direction.

[0158] That is, the reciprocating linear motion mechanism 211 converts the rotational driving force input to the

first rotating body (the rotating shaft) 222 into a reciprocating linear driving force (a reciprocating linear motion) and outputs the reciprocating linear driving force to the outside via the ram shaft connecting portion (the acting portion) 227. Therefore, by connecting the punch sleeve 2102 (see Fig. 5) to the ram shaft connecting portion (the acting portion) 227 via the ram shaft 2103, it is possible to reciprocate and linearly move the punch sleeve 2102 in a predetermined direction (the axis O direction parallel to a horizontal axis S), and it is possible to form the DI can U by performing the DI processing on the cup-shaped body W using the punch sleeve 2102 and the die 2108.

[0159] Fig. 7 is a perspective view showing an example of the cup holder drive mechanism 212.

[0160] The cup holder drive mechanism (the cam mechanism) 212 has a rotating shaft 232 to which a rotational force of an interlocking gear 229 fixed to the first rotating body (the rotating shaft) 222 of the reciprocating linear motion mechanism 211 is transmitted via a plurality of gears 238 and 239 that transmit the rotational force, a cam 233 and a rotating body 234 which are fixed around the rotating shaft 232, and an acting shaft 237 to which a cam 235 and a rotating shaft 236 which are interlocked with the cam 233 and the rotating body 234, respectively are fixed. The plurality of gears 238 and 239 are rotatably provided inside or outside the frame base 210A which will be described later.

[0161] The acting shaft 237 rotates around a central axis of the acting shaft 237 by the rotating shaft 232 being rotated. As a result, the cup holder 2106 reciprocates and linearly moves in a predetermined direction (in the example of the present embodiment, a horizontal axis S2 direction). Two operating shafts 2106a and 2106b extending from the cup holder 2106 are connected to the acting shaft 237 via a support member 231.

[0162] With the above configuration, when the rotational driving force is transmitted from a motor (not shown) to the first rotating body (the rotating shaft) 222 of the reciprocating linear motion mechanism 211, a rotational force is transmitted from the reciprocating linear motion mechanism 211 to the rotating shaft 232 via the plurality of gears 229, 238, and 239, and the cup holder 2106 of the cup holding mechanism 2101 (see Fig. 5) is reciprocated by the cup holder drive mechanism 212 in the axis O direction in conjunction with the reciprocating of the ram shaft connecting portion (the acting portion) 227 of the reciprocating linear motion mechanism 211.

[0163] The cup holder drive mechanism 212 may have a configuration in which the cup holder is reciprocated by, for example, a motor or air pressure, in addition to the configuration in which the cup holder 2106 is reciprocated by the mechanical constituent elements such as the cam or the rotating body as in the present embodiment.

[0164] Fig. 8 is a perspective view showing the frame for a drive mechanism 210 according to an embodiment of the present invention. Further, Fig. 9 is a perspective view showing the frame for a drive mechanism 210 in a

state in which the reciprocating linear motion mechanism 211 and the cup holder drive mechanism (a cam mechanism) 212 are fixed.

[0165] The frame for a drive mechanism 210 of the present embodiment includes a frame base 210A and an extension portion 210B. The frame base 210A and the extension portion 210B may be integrally formed of the same members or may be ones obtained by fixing separate members to each other to be integrated.

[0166] The frame base 210A forms a box-like body the whole of which is formed of a metal, and has a front plate 241, a lower plate (a bottom plate) 242, one side plate 243A, another side plate 243B, and a back plate 244, and a part of the front plate 241 is attachably and detachably formed. The front plate 241 has an open portion 241A and a lid plate 241B. That is, the open portion 241A is formed in a part of the front plate 241, and the lid plate 241B covers the open portion 241A.

[0167] The front plate 241, the lower plate 242, one side plate 243A, another side plate 243B, and the back plate 244 are integrally formed by, for example, casting. In addition to the integral forming by the casting, these plates constituting the frame base 210A may be fixed to each other by screws, welding, or the like to be integrally formed as a whole.

[0168] An upper portion of the back plate 244 is formed to extend upward more than the front plate 241. That is, the back plate 244 is formed such that the upper portion protrudes in a substantially semicircular shape. Thus, a circular opening 246 for attaching the reciprocating linear motion mechanism 211 is formed in the back plate 244. The circular opening 246 is an opening extending along a thickness direction of the back plate 244.

[0169] An opening diameter of the circular opening 246 is formed to be larger than an outer diameter of the cylindrical housing 221 constituting a part of the reciprocating linear motion mechanism 211.

[0170] As shown in Fig. 9, the reciprocating linear motion mechanism 211 is attached to such a circular opening 246. The reciprocating linear motion mechanism 211 is fitted into the circular opening 246 such that an outer circumferential surface of the cylindrical housing 221 is in contact with an inner circumferential surface of the circular opening 246. Then, a rib 221a formed on the outer circumferential surface of the housing 221 of the reciprocating linear motion mechanism 211 and a bolt hole 246c formed on an edge of a front side of the circular opening 246 (the open portion 241A side) are fastened with bolts, and thus the reciprocating linear motion mechanism 211 is firmly fixed to the frame base 210A via the back plate 244.

[0171] The first rotating body (the rotating shaft) 222 of the reciprocating linear motion mechanism 211 fixed to the back plate 244 is connected to a rotating shaft of a motor (not shown) disposed outside the back plate 244.

[0172] The cup holder drive mechanism (the cam mechanism) 212 is supported between the front plate 241 and the back plate 244 of the frame base 210A. More

specifically, support openings 241a and 241b are formed in the front plate 241, and support openings 244a and 244b are also formed in the back plate 244. Among these, the support opening 241a and the support opening 244a, and the support opening 241b and the support opening 244b are formed on the same central axis to face each other.

[0173] The rotating shaft 232 of the cup holder drive mechanism (the cam mechanism) 212 is supported by the support opening 241a and the support opening 244a. Further, the acting shaft 237 of the cup holder drive mechanism (the cam mechanism) 212 is supported by the support opening 241b and the support opening 244b. As a result, the cup holder drive mechanism (the cam mechanism) 212 is supported between the front plate 241 and the back plate 244 of the frame base 210A.

[0174] In the present embodiment, the extension portion 210B of the frame for a drive mechanism 210 is formed to be in contact with an outer surface of one side plate 243A constituting a part of the frame base 210A. Such an extension portion 210B may be formed of a metal plate or the like, as in the frame base 210A. The extension portion 210B and the frame base 210A are fastened to be integrally formed as a whole with, for example, bolts and the like. For example, the extension portion 210B and the frame base 210A may be integrally fixed by welding or the like, or may be integrally formed by casting.

[0175] For example, the cup holder 2106, the biasing means 2115, the die 2108, the bottom former 2110 (see Fig. 5), and the like are disposed on an upper portion of the extension portion 210B. Some of these members (for example, the die 2108 and the bottom former 2110) may be fixed to the upper portion of the extension portion 210B with, for example, bolts and the like.

[0176] The extension portion 210B does not necessarily have to be integrally formed with the frame base 210A to which the reciprocating linear motion mechanism 211 is attached. That is, a frame corresponding to the extension portion 210B, to which a die, a cup holder, and the like are attached may be formed adjacent to the frame base 210A as a separate member from the frame base 210A.

[0177] As described above, according to the frame for a drive mechanism 210 of the present embodiment, the frame for a drive mechanism 210 for attaching the reciprocating linear motion mechanism 211 thereto is integrally formed, and the reciprocating linear motion mechanism 211 is housed in a circular opening 246 capable of housing the reciprocating linear motion mechanism 211 and is fixed thereto. In the present embodiment, the attachment accuracy of the reciprocating linear motion mechanism 211 can be improved as compared with the frame for a drive mechanism of the related art which is constituted by the division bodies obtained by dividing one into a plurality. As a result, it is possible to suppress vibration during the operation of the reciprocating linear motion mechanism 211 and the shake of the reciprocating motion of the ram shaft 2103, and thus it is possible to per-

form the drawing and ironing processing on the cup-shaped body W with high accuracy. Further, it is possible to remove the reciprocating linear motion mechanism 211 forward from the circular opening 246 without dividing the frame for a drive mechanism 210, and thus the maintainability is excellent.

[0178] According to the present embodiment, it is possible to improve the forming accuracy of the can U, to suppress the occurrence of a defective can, and to improve the production efficiency of the can U.

[0179] Further, in the present embodiment, the cup holder drive mechanism 212 is supported between the front plate 241 and the back plate 244. In this case, since the cup holder drive mechanism 212 is supported by the frame for a drive mechanism 210 having a high rigidity in a state in which both ends thereof are supported, the operating accuracy of the cup holder drive mechanism 212 is stably improved. Therefore, the cup-shaped body W can be stably pressed by the cup holder 2106.

[0180] Further, in the present embodiment, the gears 229, 238, and 239 transmit the rotational force of the reciprocating linear motion mechanism 211 to the cup holder drive mechanism 212. In this case, it is possible to suppress loss in the force transmitted from the reciprocating linear motion mechanism 211 to the cup holder drive mechanism 212 while the can body maker 2100 is compactly configured. Further, it is possible to stably synchronize the operation of the reciprocating linear motion mechanism 211 with the operation of the cup holder drive mechanism 212.

[0181] Further, in the present embodiment, the back plate 244 extends upward more than the front plate 241. In this case, it is possible to dispose at least a part of the circular opening 246 in a portion of the back plate 244 protruding upward. It is possible to easily attach and detach the reciprocating linear motion mechanism 211 to and from the circular opening 246 while the frame for a drive mechanism 210 is compactly configured.

[0182] Further, in the present embodiment, a part (the lid plate 241B) of the front plate 241 is attachable to and detachable from another part. In this case, by removing the lid plate 241B from the open portion 241A, it is easy to access the inside of the frame for a drive mechanism 210. Therefore, the workability at the time of assembling and the maintainability of the can body maker 2100 is excellent.

[0183] Further, in the present embodiment, the extension portion 210B on which the die 2108 and the bottom former 2110 are disposed is integrally fixed to the outside of the side plate 243A. In this case, since the frame base 210A and the extension portion 210B are integrally fixed to each other, the rigidity of the extension portion 210B is ensured. Therefore, even if the die 2108 having a large weight and the bottom former 2110 are disposed on the extension portion 210B, the forming accuracy of the can U is maintained well.

[0184] In the above, although one embodiment of the present invention has been described, this embodiment

is presented as an example and is not intended to limit the scope of the invention. This embodiment can be implemented in various other forms, and various additions, omissions, replacements, and changes can be made without departing from the gist of the invention. This embodiment and modifications thereof are included in the scope and gist of the invention, as well as in the scope of the invention described in the claims and the equivalent scope thereof. That is, for example, each configuration of the first embodiment may be combined with the second embodiment.

[0185] According to the can body maker of the present invention, it is possible to improve the forming accuracy of a can, to suppress the occurrence of a defective can, and to improve the production efficiency of a can. Further, it is possible to suppress loss in a force transmitted from the cup holder drive mechanism to the cup holding mechanism to be small and to extend component life.

[0186] Further, according to the frame for a drive mechanism of the present invention, it is possible to improve the attachment accuracy of the reciprocating linear motion mechanism to the frame, thereby to suppress the shake of the reciprocating motion of the ram shaft, and thus it is possible to perform the drawing and ironing processing on the cup-shaped body with high accuracy. Further, it is possible to remove the reciprocating linear motion mechanism from the circular opening without dividing the frame for a drive mechanism, and thus the maintainability is excellent. Therefore, the present invention has industrial applicability.

[0187] While preferred embodiments of the invention have been described and illustrated above, it should be understood that these are exemplary of the invention and are not to be considered as limiting. Additions, omissions, substitutions, and other modifications can be made without departing from the spirit or scope of the present invention. Accordingly, the invention is not to be considered as being limited by the foregoing description, and is only limited by the scope of the appended claims.

EXPLANATION OF REFERENCES

[0188]

- 101, 2100 Can body maker
- 102, 2102 Punch
- 103, 2103 Ram shaft
- 104, 211 Reciprocating linear motion mechanism (ram shaft drive mechanism)
- 105, 2105 Bearing
- 107, 2107 Through hole
- 108, 2108 Die
- 109, 2108a End face
- 110, 212 Cup holder drive mechanism (cam mechanism)
- 112 Cam
- 114 Oscillation unit
- 115 Arm

120 Gear
 130 Cup holding mechanism
 131 Cup holder sleeve
 132 Rod
 133 Biasing unit
 210 Frame for drive mechanism
 210A Frame base
 210B Extension portion
 221 Housing
 229, 238, 239 Gear
 241 Front plate
 242 Lower plate (bottom plate)
 243A One side plate
 243B Another side plate
 244 Back plate
 246 Circular opening
 2106 Cup holder
 C Rotation axis
 J1 First central axis
 J2 Second central axis
 O Axis (central axis)
 W Cup-shaped body

Claims

1. A can body maker comprising:

a ram shaft extending in a front-rear direction;
 a punch disposed at a front end portion of the ram shaft;
 a reciprocating linear motion mechanism connected to a rear end portion of the ram shaft to reciprocate and linearly move the ram shaft in the front-rear direction;
 a die having a through hole into which the punch is inserted;
 a cup holding mechanism pressing a cup-shaped body against an end face in which the through hole of the die opens; and
 a cup holder drive mechanism that oscillates the cup holding mechanism in the front-rear direction, wherein the cup holder drive mechanism has a cam structure and is disposed directly below the cup holding mechanism.

2. The can body maker according to claim 1, further comprising:

a gear transmitting a rotational driving force around a rotation axis of the reciprocating linear motion mechanism to the cup holder drive mechanism.

3. The can body maker according to claim 1 or 2,

wherein the cup holder drive mechanism has a cam which is rotated,
 an oscillation unit oscillated by being in contact

with the cam, and
 a pair of arms disposed on both sides of the ram shaft and oscillate together with the oscillation unit to move the cup holding mechanism back and forth.

4. The can body maker according to any one of claims 1 to 3,

wherein the cup holding mechanism has a cup holder sleeve, and
 a biasing unit allowing the cup holder sleeve to be biased forward with air pressure.

5. The can body maker according to any one of claims 1 to 4, further comprising:

a bearing supporting the ram shaft to be slidable in the front-rear direction,
 wherein the cup holder drive mechanism is disposed directly below the bearing.

6. The can body maker according to any one of claims 1 to 5, further comprising:

bearings supporting the ram shaft to be slidable in the front-rear direction,
 wherein a pair of the bearings are provided at an interval in the front-rear direction, and
 wherein the pair of bearings are integrally formed.

7. A frame for a drive mechanism provided in a can body maker having a ram shaft which has a punch provided at a front end portion thereof, a die in which a through hole into which the punch is inserted is formed and a cup-shaped body extruded by the punch is passed through the through hole to perform drawing processing and ironing processing on the cup-shaped body, a cup holder which presses the cup-shaped body against an end face of the die, and a drive mechanism reciprocating the ram shaft, to house the drive mechanism,

wherein the drive mechanism has a reciprocating linear motion mechanism reciprocating the ram shaft,
 wherein the reciprocating linear motion mechanism has a housing in a cylindrical shape, and
 wherein the frame for a drive mechanism is formed by side plates, a bottom plate, a front plate, and a back plate being integrally fixed to each other, and a circular opening surrounding a circumferential surface of the housing to house the reciprocating linear motion mechanism is integrally formed in the back plate.

8. The frame for a drive mechanism according to claim

7,

wherein the drive mechanism has a cup holder
drive mechanism reciprocating the cup holder,
and
wherein the cup holder drive mechanism is sup-
ported between the front plate and the back
plate.

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9. The frame for a drive mechanism according to claim 8, wherein a gear transmitting a rotational force of the reciprocating linear motion mechanism to the cup holder drive mechanism is rotatably formed in the reciprocating linear motion mechanism.

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10. The frame for a drive mechanism according to any one of claims 7 to 9, wherein the back plate extends upward more than the front plate.

11. The frame for a drive mechanism according to any one of claims 7 to 10, wherein a part of the front plate is attachably and detachably formed.

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12. The frame for a drive mechanism according to any one of claims 7 to 11, wherein an extension portion in which the die is disposed is integrally fixed to an outside of the side plate.

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13. A can body maker which includes the frame for a drive mechanism according to any one of claims 7 to 12, comprising at least:

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the frame for a drive mechanism; and
the reciprocating linear motion mechanism.

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14. A cup holder with a driving mechanism comprising:

a cup holding mechanism pressing a cup-
shaped body against an end face in which a
through hole of a die opens; and
a cup holder drive mechanism that oscillates the
cup holding mechanism in the front-rear direc-
tion,
wherein the cup holder drive mechanism has a
cam structure and is disposed directly below the
cup holding mechanism.

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FIG. 1

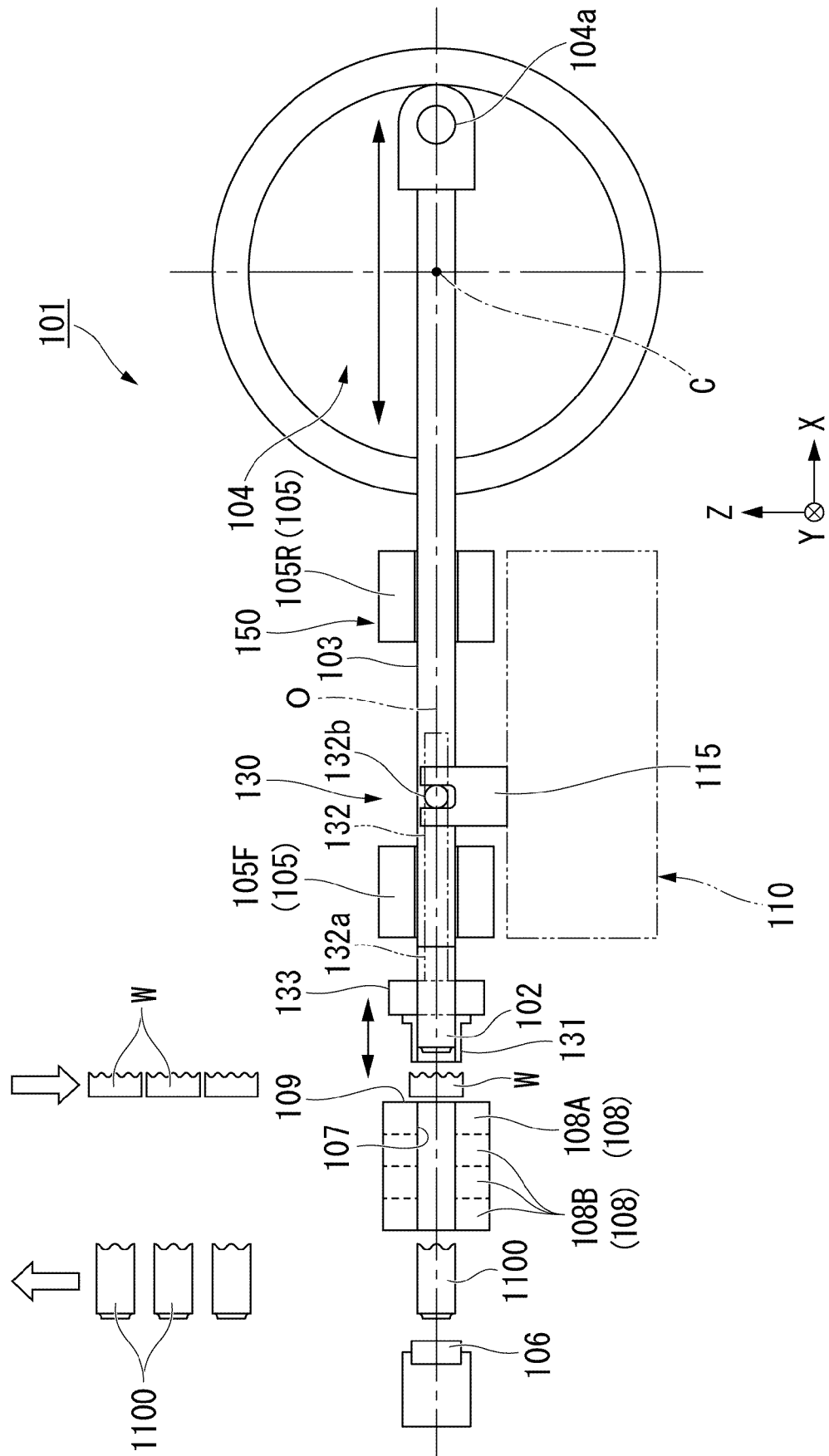


FIG. 2

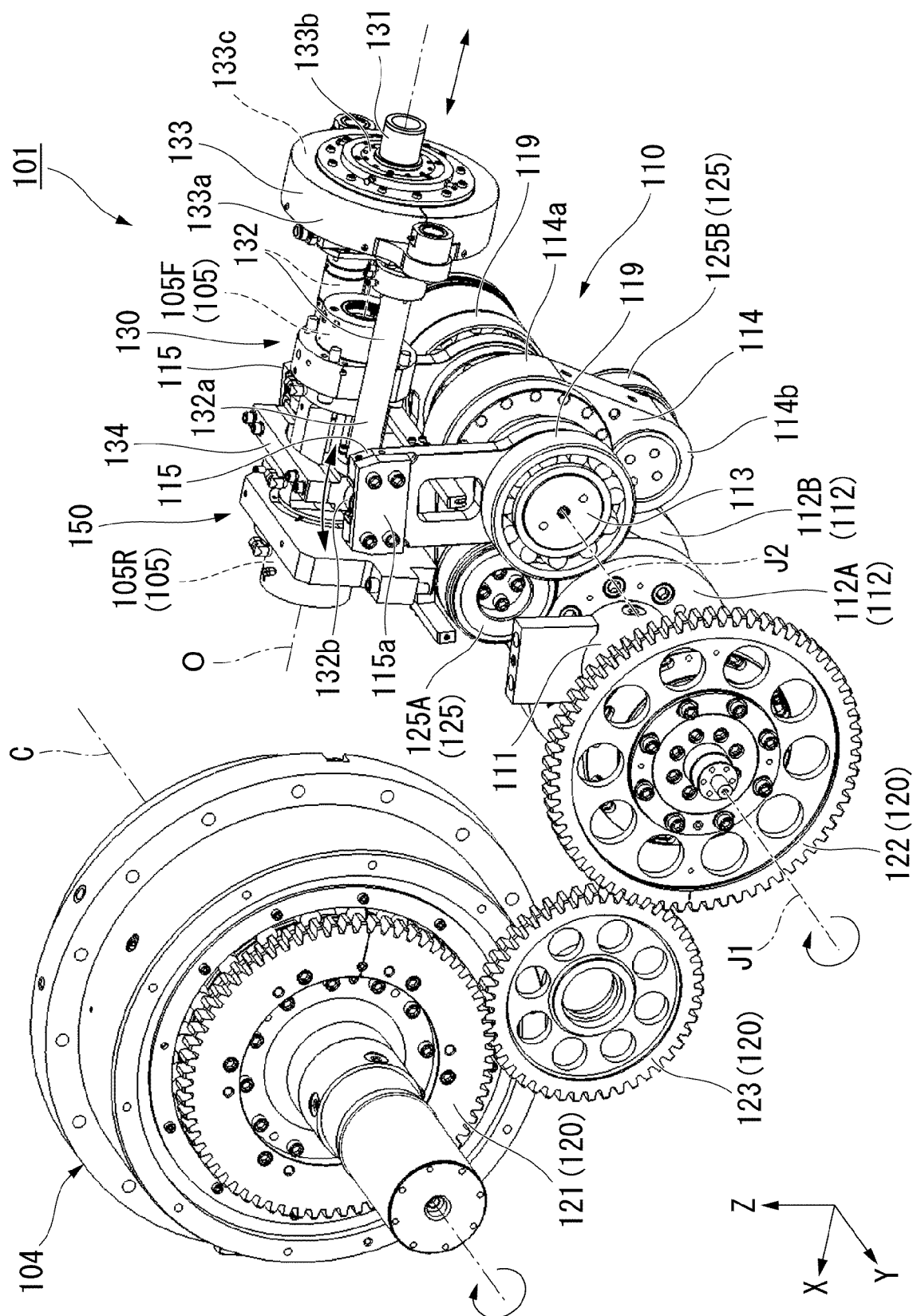


FIG. 3

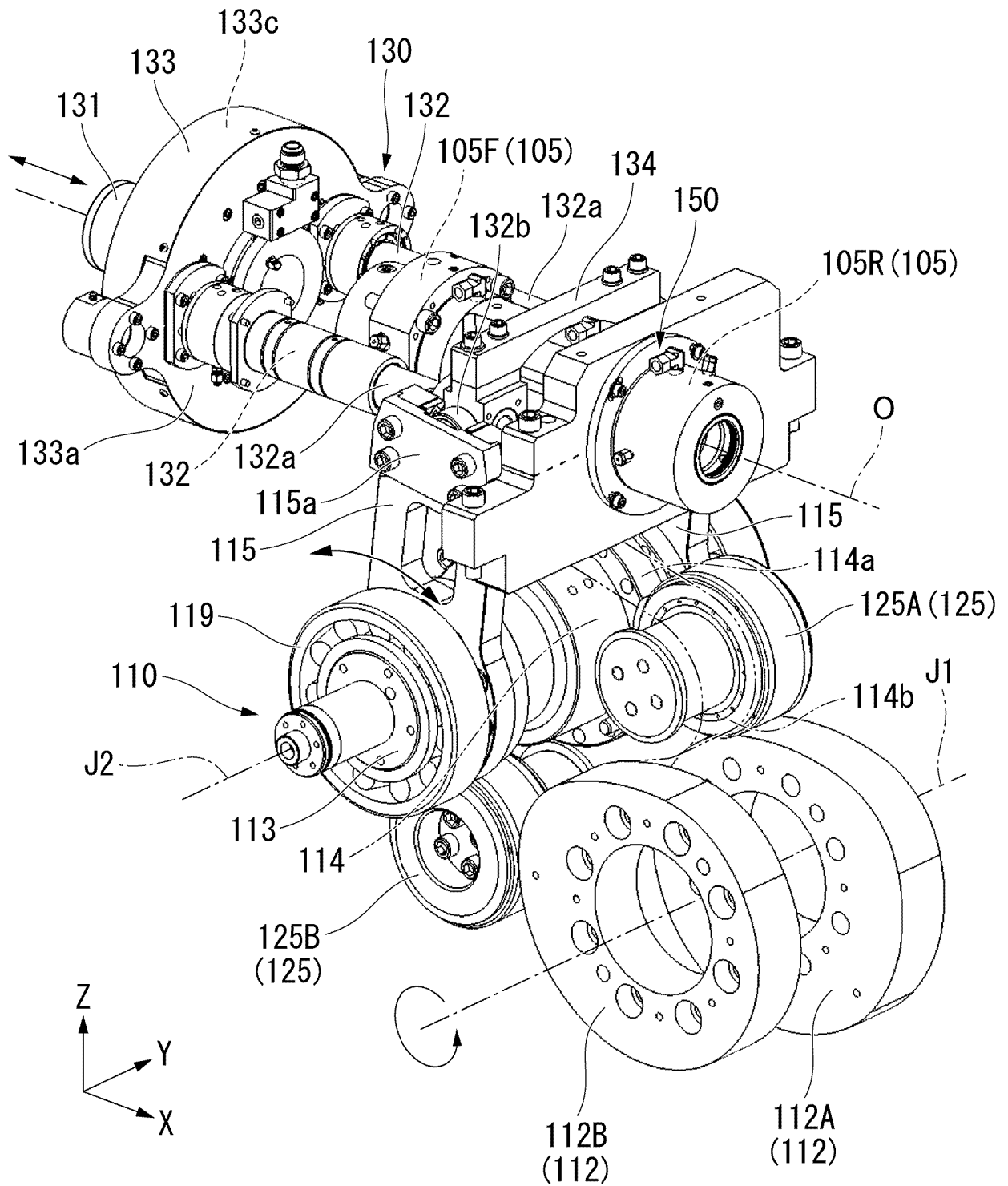


FIG. 4A

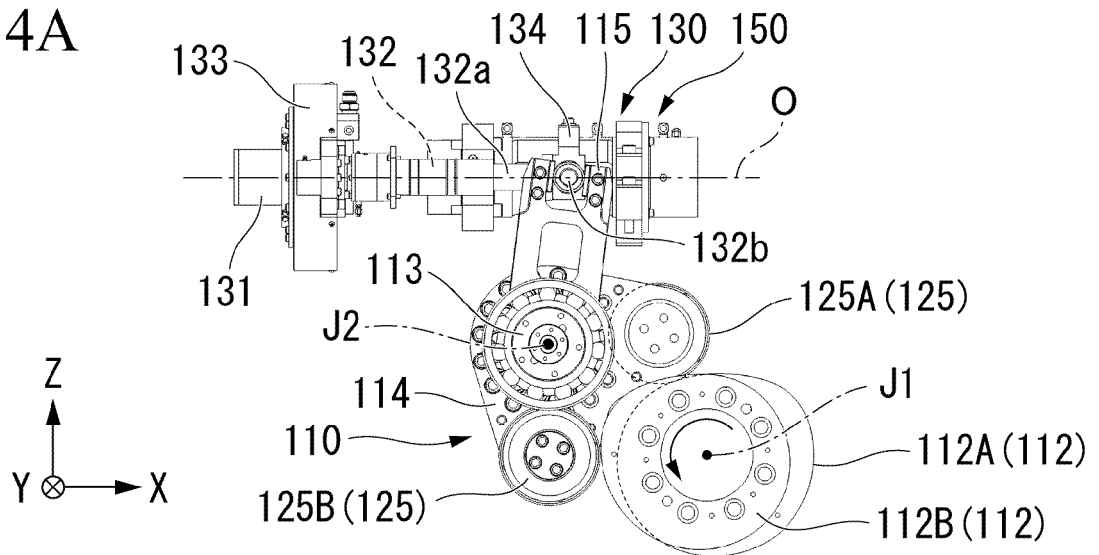


FIG. 4B

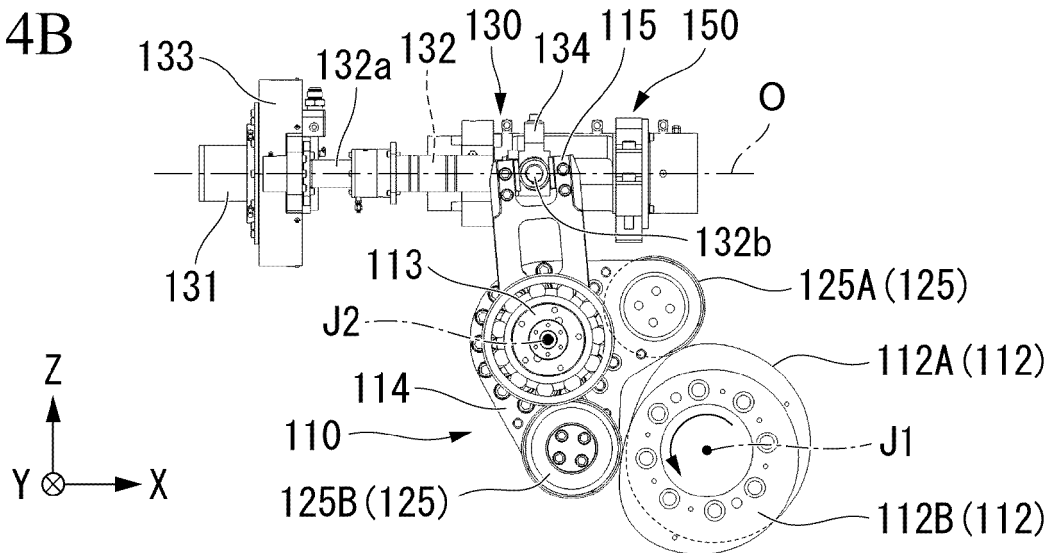


FIG. 4C

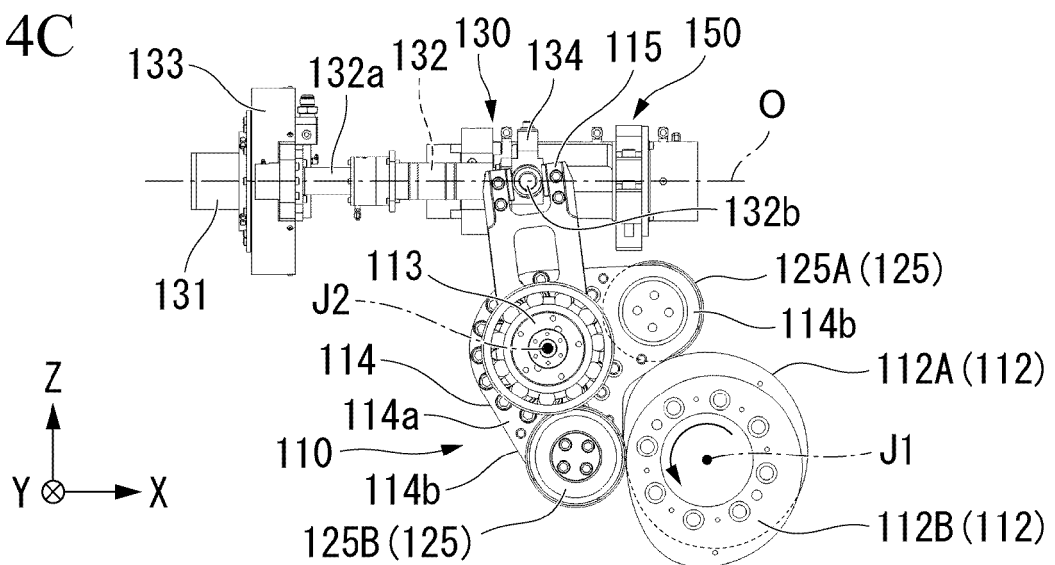


FIG. 5

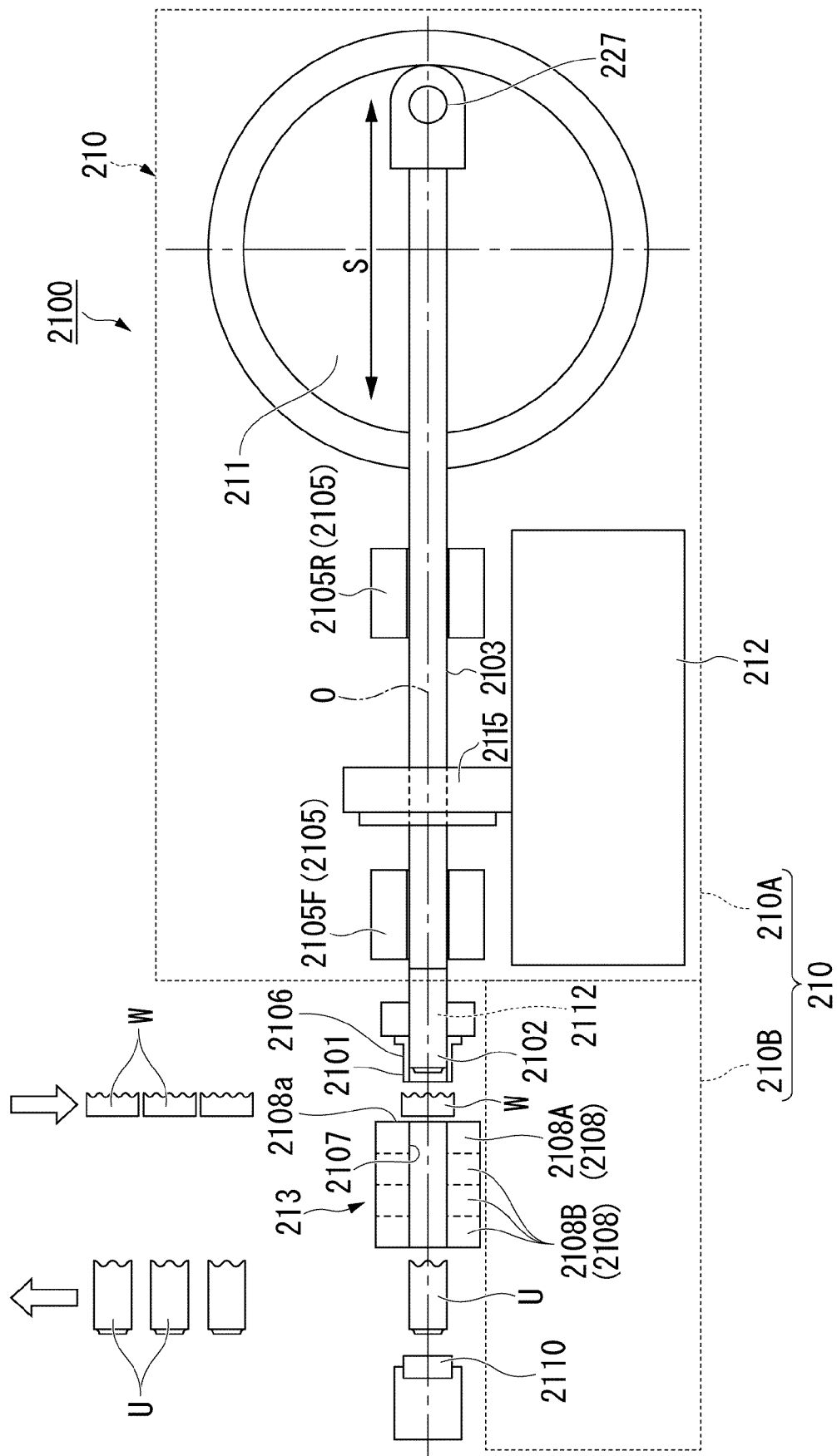
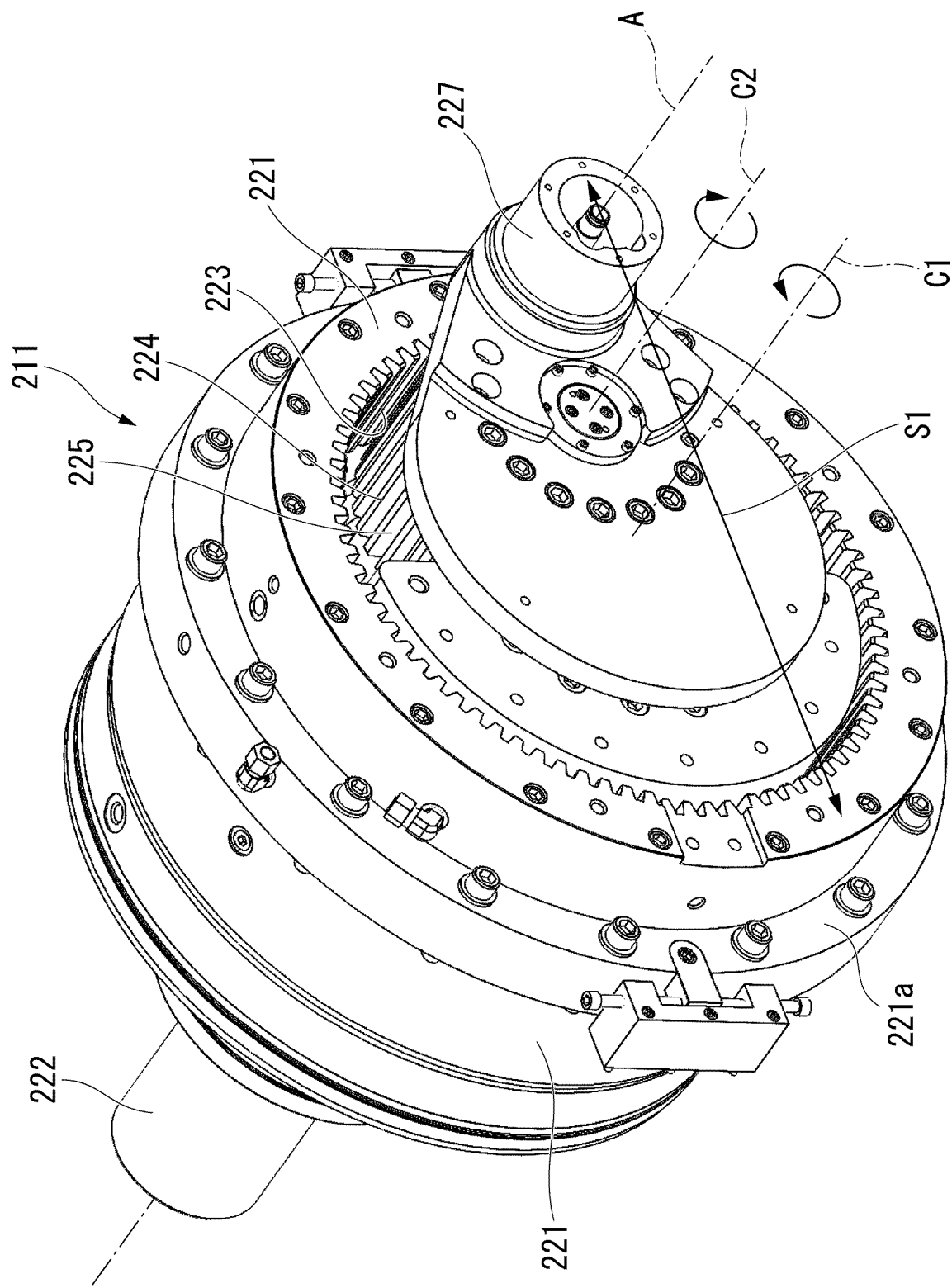


FIG. 6



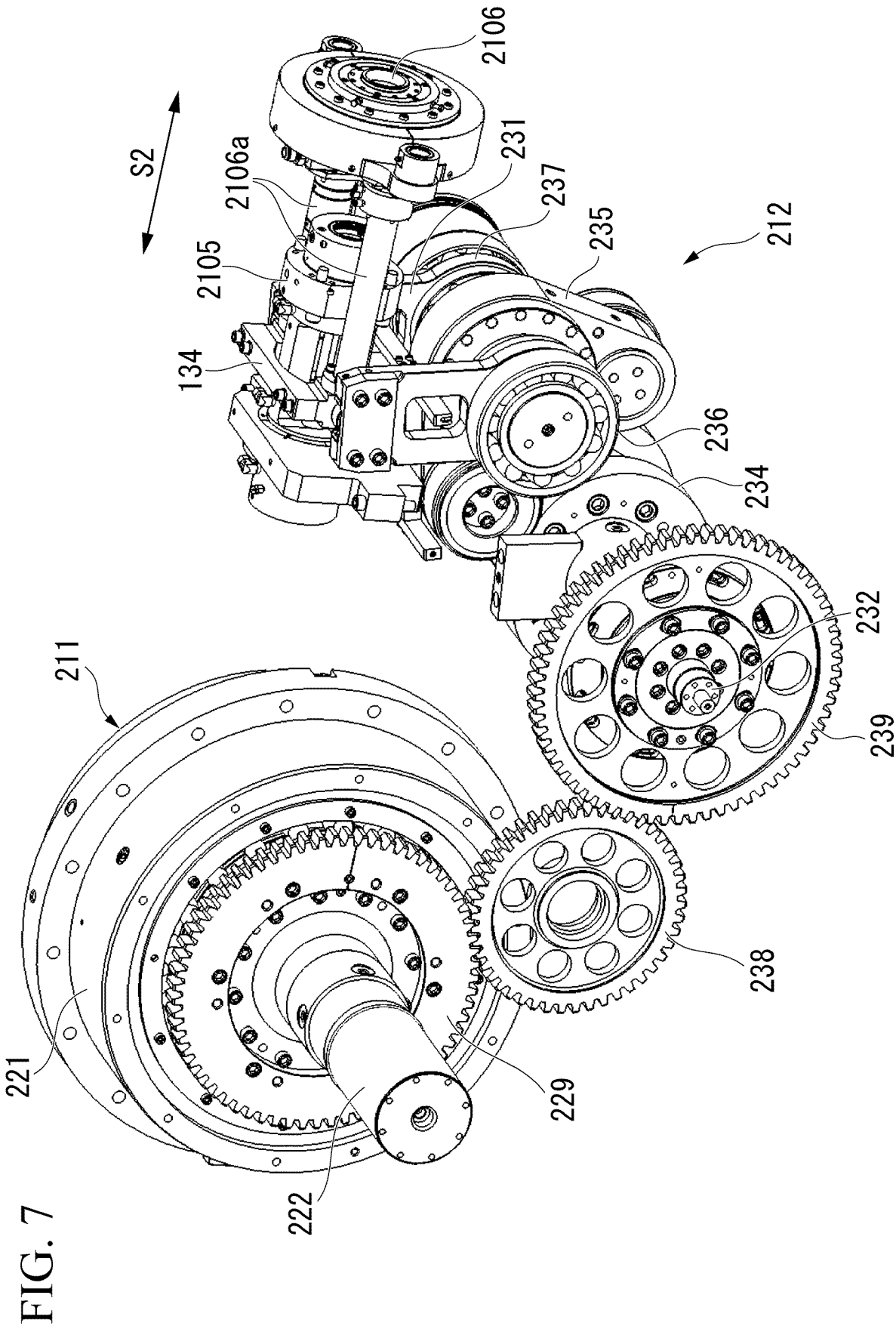


FIG. 8

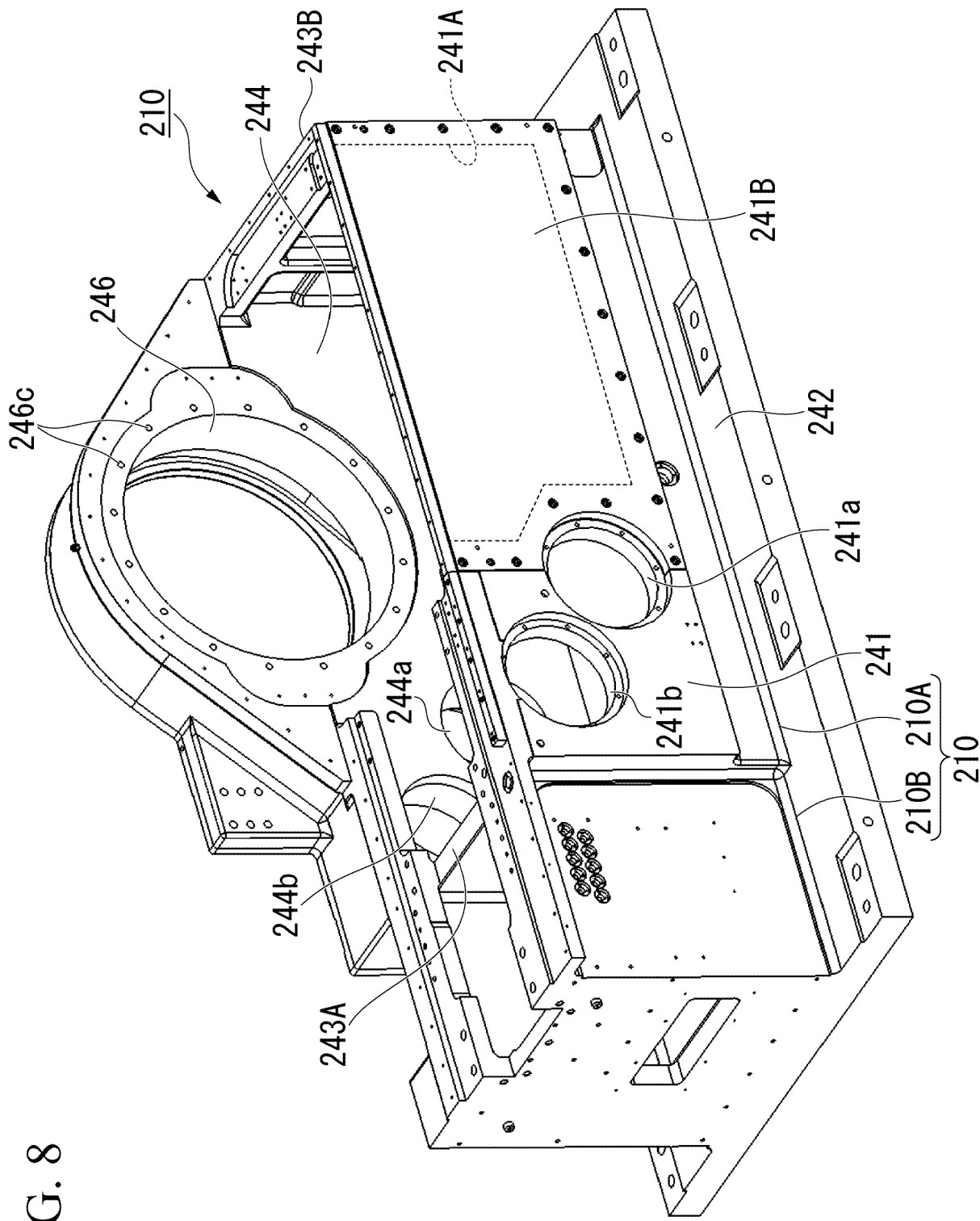
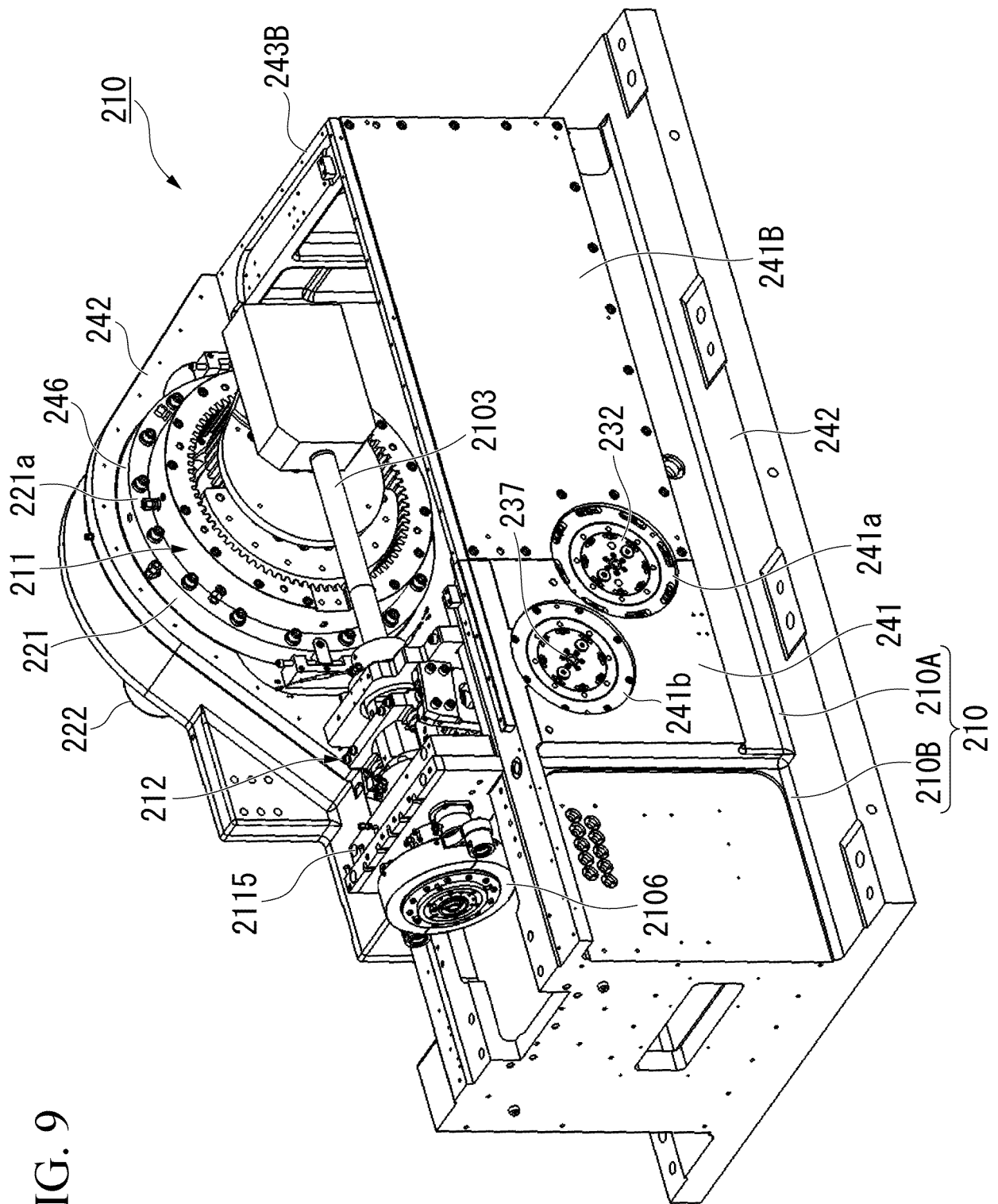


FIG. 9



REFERENCES CITED IN THE DESCRIPTION

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